STORMWATER REPORT & CALCULATIONS

MA DEP Stormwater Management Policy

Project

421 Forest Street
Rockland, MA 02370
Assessor's Map 14 Lot 79

Applicant

Melissa McInnis & Dennis Benoit
21 Accord Pond Drive
Hingham, MA 02043

Date: August 27, 2024
Revised: November 5, 2024

Prepared by:

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TABLE OF CONTENTS

Project Narrative
421 Forest Street, Rockland

Project Summary

The Property Owners propose to construct a Commercial Building and associated paved parking and access areas, utilities, stormwater controls, grading and utilities at 421 Forest Street, Rockland MA, identified as Assessor's Parcel 14-79.

The property is approximately 29,122 s.f. and is entirely upland. There is a bordering vegetated wetland offsite to the southwest. The northern portion of the property has frontage on Forest Street and is developed with a single family home. The project is proposed on the southern portion of the property which has frontage on VFW Drive and is developed with a curb cut and gravel area.

This report contains calculations of stormwater runoff for the pre-development and post-development conditions in accordance with the Massachusetts Department of Environmental Protection Stormwater Handbook.

The property is not located in an estimated or priority habitat, nor are there an potential or certified vernal pools, as shown on the Natural Heritage and Endangered Species (NHESP) Atlas

There are no areas of critical environmental concern, or areas containing outstanding resource waters.

The property is not located with a Zone X as shown on the FEMA Community Panel 25023C 0039K dated July 16, 2021.

Pre-Development Condition

The site is currently developed with a single family home and paved driveway off of Forest Street, and curb cut and gravel area off of VFW Drive.

Soils information was obtained from the Soils Conservation Service (SCS) Survey of Plymouth County, Massachusetts and soil testing data performed by Morse Engineering Company, Inc. in July 2023. The soils are classified as "453B - Gloucester – Canton Complex, 3 to 8 percent slopes"– Hydrologic Soil Group A.

In both the pre-development and post-development stormwater analysis, the watershed area analyzed was approximately 0.669-acres consisting of the subject property.

HydroCAD version 9.0 was utilized to develop the stormwater model. HydroCAD uses the SCS Technical Release 20 (TR-20) Program for Formulation Hydrology developed by the Soil Conservation Service (SCS) to develop rates of runoff from subcatchment areas.

Drainage calculations were performed for the pre-development condition for the 2, 10, 25 and 100-year Type III storm events. Refer to "Pre-Development HydroCAD Analysis" in Appendix A" for computer results, soil characteristics, cover descriptions and times of concentrations for all subareas.

Post-Development Condition

In the post-development condition stormwater analysis, watershed areas were analyzed for purposes of designing a drainage system to accommodate the proposed development. The objective in designing the proposed drainage facilities for the project was to maintain existing drainage patterns to the extent practicable and to ensure that the post-development rates and volumes of runoff to the abutting properties will be reduced. The design points for the post-development design condition correspond to the design points for the pre-development design condition. Runoff from the proposed roof and pavement areas will be captured and directed to a subsurface recharge system. The post-development rates and volumes of runoff are equal or less than pre-development conditions.

A comparison of the pre-development and post-development runoff characteristics indicates that the peak rates and volumes of runoff will be equal or less than the pre-development condition for all storm events post-development. Refer to "Proposed Conditions HydroCAD Analysis" in Appendix B for results:

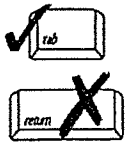
The stormwater management system was designed to be in compliance with the DEP Stormwater Management Policy. See "Summary of Stormwater Standards 1-10" in Appendix C.

Massachusetts Department of Environmental Protection
Bureau of Resource Protection - Wetlands Program

Checklist for Stormwater Report

A. Introduction

Important: When filling out forms on the computer, use only the tab key to move your cursor - do not use the return key.



A Stormwater Report must be submitted with the Notice of Intent permit application to document compliance with the Stormwater Management Standards. The following checklist is NOT a substitute for the Stormwater Report (which should provide more substantive and detailed information) but is offered here as a tool to help the applicant organize their Stormwater Management documentation for their Report and for the reviewer to assess this information in a consistent format. As noted in the Checklist, the Stormwater Report must contain the engineering computations and supporting information set forth in Volume 3 of the Massachusetts Stormwater Handbook. The Stormwater Report must be prepared and certified by a Registered Professional Engineer (RPE) licensed in the Commonwealth.

The Stormwater Report must include:

- The Stormwater Checklist completed and stamped by a Registered Professional Engineer (see page 2) that certifies that the Stormwater Report contains all required submittals.[1] This Checklist is to be used as the cover for the completed Stormwater Report.
- Applicant/Project Name
- Project Address
- Name of Firm and Registered Professional Engineer that prepared the Report
- Long-Term Pollution Prevention Plan required by Standards 4-6
- Construction Period Pollution Prevention and Erosion and Sedimentation Control Plan required by Standard 8[2]
- Operation and Maintenance Plan required by Standard 9

In addition to all plans and supporting information, the Stormwater Report must include a brief narrative describing stormwater management practices, including environmentally sensitive site design and LID techniques, along with a diagram depicting runoff through the proposed BMP treatment train. Plans are required to show existing and proposed conditions, identify all wetland resource areas, NRCS soil types, critical areas, Land Uses with Higher Potential Pollutant Loads (LUHPPL), and any areas on the site where infiltration rate is greater than 2.4 inches per hour. The Plans shall identify the drainage areas for both existing and proposed conditions at a scale that enables verification of supporting calculations.

As noted in the Checklist, the Stormwater Management Report shall document compliance with each of the Stormwater Management Standards as provided in the Massachusetts Stormwater Handbook. The soils evaluation and calculations shall be done using the methodologies set forth in Volume 3 of the Massachusetts Stormwater Handbook.

To ensure that the Stormwater Report is complete, applicants are required to fill in the Stormwater Report Checklist by checking the box to indicate that the specified information has been included in the Stormwater Report. If any of the information specified in the checklist has not been submitted, the applicant must provide an explanation. The completed Stormwater Report Checklist and Certification must be submitted with the Stormwater Report.

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[1] The Stormwater Report may also include the Illicit Discharge Compliance Statement required by Standard 10. If not included in the Stormwater Report, the Illicit Discharge Compliance Statement must be submitted prior to the discharge of stormwater runoff to the post-construction best management practices.

[2] For some complex projects, it may not be possible to include the Construction Period Erosion and Sedimentation Control Plan in the Stormwater Report. In that event, the issuing authority has the discretion to issue an Order of Conditions that approves the project and includes a condition requiring the proponent to submit the Construction Period Erosion and Sedimentation Control Plan before commencing any land disturbance activity on the site.

Massachusetts Department of Environmental Protection
Bureau of Resource Protection - Wetlands Program

Checklist for Stormwater Report

B. Stormwater Checklist and Certification

The following checklist is intended to serve as a guide for applicants as to the elements that ordinarily need to be addressed in a complete Stormwater Report. The checklist is also intended to provide conservation commissions and other reviewing authorities with a summary of the components necessary for a comprehensive Stormwater Report that addresses the ten Stormwater Standards.

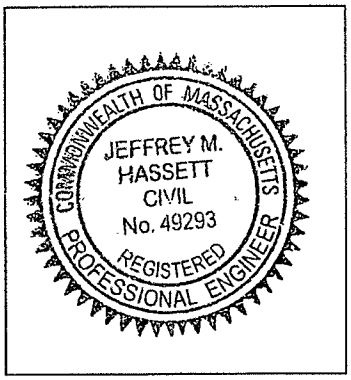
Note: Because stormwater requirements vary from project to project, it is possible that a complete Stormwater Report may not include information on some of the subjects specified in the Checklist. If it is determined that a specific item does not apply to the project under review, please note that the item is not applicable (N.A.) and provide the reasons for that determination.

A complete checklist must include the Certification set forth below signed by the Registered Professional Engineer who prepared the Stormwater Report.

Registered Professional Engineer's Certification

I have reviewed the Stormwater Report, including the soil evaluation, computations, Long-term Pollution Prevention Plan, the Construction Period Erosion and Sedimentation Control Plan (if included), the Long-term Post-Construction Operation and Maintenance Plan, the Illicit Discharge Compliance Statement (if included) and the plans showing the stormwater management system, and have determined that they have been prepared in accordance with the requirements of the Stormwater Management Standards as further elaborated by the Massachusetts Stormwater Handbook. I have also determined that the information presented in the Stormwater Checklist is accurate and that the information presented in the Stormwater Report accurately reflects conditions at the site as of the date of this permit application.

Registered Professional Engineer Block and Signature



8/27/24

Signature and Date

Checklist

Project Type: Is the application for new development, redevelopment, or a mix of new and redevelopment?

☐ New development

☐ Redevelopment

☒ Mix of New Development and Redevelopment

Checklist for Stormwater Report

Checklist (continued)

LID Measures: Stormwater Standards require LID measures to be considered. Document what environmentally sensitive design and LID Techniques were considered during the planning and design of the project:

- ☒ No disturbance to any Wetland Resource Areas
- ☐ Site Design Practices (e.g. clustered development, reduced frontage setbacks)
- ☐ Reduced Impervious Area (Redevelopment Only)
- ☒ Minimizing disturbance to existing trees and shrubs
- ☐ LID Site Design Credit Requested:
  - ☐ Credit 1
  - ☐ Credit 2
  - ☐ Credit 3
- ☐ Use of "country drainage" versus curb and gutter conveyance and pipe
- ☐ Bioretention Cells (includes Rain Gardens)
- ☐ Constructed Stormwater Wetlands (includes Gravel Wetlands designs)
- ☐ Treebox Filter
- ☐ Water Quality Swale
- ☐ Grass Channel
- ☐ Green Roof
- ☐ Other (describe): _____

Standard 1: No New Untreated Discharges

- ☒ No new untreated discharges
- ☒ Outlets have been designed so there is no erosion or scour to wetlands and waters of the Commonwealth
- ☒ Supporting calculations specified in Volume 3 of the Massachusetts Stormwater Handbook included.

Checklist for Stormwater Report

Checklist (continued)

Standard 2: Peak Rate Attenuation

☐ Standard 2 waiver requested because the project is located in land subject to coastal storm flowage and stormwater discharge is to a wetland subject to coastal flooding.

☒ Evaluation provided to determine whether off-site flooding increases during the 100-year 24-hour storm.

☒ Calculations provided to show that post-development peak discharge rates do not exceed pre-development rates for the 2-year and 10-year 24-hour storms. If evaluation shows that off-site flooding increases during the 100-year 24-hour storm, calculations are also provided to show that post-development peak discharge rates do not exceed pre-development rates for the 100-year 24-hour storm.

Standard 3: Recharge

☒ Soil Analysis provided.

☒ Required Recharge Volume calculation provided.

☐ Required Recharge volume reduced through use of the LID site Design Credits.

☒ Sizing the infiltration, BMPs is based on the following method: Check the method used.

☐ Static ☒ Simple Dynamic ☐ Dynamic Field[1]

☒ Runoff from all impervious areas at the site discharging to the infiltration BMP.

☐ Runoff from all impervious areas at the site is *not* discharging to the infiltration BMP and calculations are provided showing that the drainage area contributing runoff to the infiltration BMPs is sufficient to generate the required recharge volume.

☒ Recharge BMPs have been sized to infiltrate the Required Recharge Volume.

☐ Recharge BMPs have been sized to infiltrate the Required Recharge Volume *only* to the maximum extent practicable for the following reason:

- ☐ Site is comprised solely of C and D soils and/or bedrock at the land surface
- ☐ M.G.L. c. 21E sites pursuant to 310 CMR 40.0000
- ☐ Solid Waste Landfill pursuant to 310 CMR 19.000
- ☐ Project is otherwise subject to Stormwater Management Standards only to the maximum extent practicable.

☒ Calculations showing that the infiltration BMPs will drain in 72 hours are provided.

☐ Property includes a M.G.L. c. 21E site or a solid waste landfill and a mounding analysis is included.

[1] 80% TSS removal is required prior to discharge to infiltration BMP if Dynamic Field method is used.

Checklist for Stormwater Report

Checklist (continued)

Standard 3: Recharge (continued)

☐ The infiltration BMP is used to attenuate peak flows during storms greater than or equal to the 10-year 24-hour storm and separation to seasonal high groundwater is less than 4 feet and a mounding analysis is provided.

☒ Documentation is provided showing that infiltration BMPs do not adversely impact nearby wetland resource areas.

Standard 4: Water Quality

The Long-Term Pollution Prevention Plan typically includes the following:

- Good housekeeping practices;
- Provisions for storing materials and waste products inside or under cover;
- Vehicle washing controls;
- Requirements for routine inspections and maintenance of stormwater BMPs;
- Spill prevention and response plans;
- Provisions for maintenance of lawns, gardens, and other landscaped areas;
- Requirements for storage and use of fertilizers, herbicides, and pesticides;
- Pet waste management provisions;
- Provisions for operation and management of septic systems;
- Provisions for solid waste management;
- Snow disposal and plowing plans relative to Wetland Resource Areas;
- Winter Road Salt and/or Sand Use and Storage restrictions;
- Street sweeping schedules;
- Provisions for prevention of illicit discharges to the stormwater management system;
- Documentation that Stormwater BMPs are designed to provide for shutdown and containment in the event of a spill or discharges to or near critical areas or from LUHPPL;
- Training for staff or personnel involved with implementing Long-Term Pollution Prevention Plan;
- List of Emergency contacts for implementing Long-Term Pollution Prevention Plan.

☒ A Long-Term Pollution Prevention Plan is attached to Stormwater Report and is included as an attachment to the Wetlands Notice of Intent.

☐ Treatment BMPs subject to the 44% TSS removal pretreatment requirement and the one inch rule for calculating the water quality volume are included, and discharge:

- ☐ is within the Zone II or Interim Wellhead Protection Area
- ☐ is near or to other critical areas
- ☐ is within soils with a rapid infiltration rate (greater than 2.4 inches per hour)
- ☐ involves runoff from land uses with higher potential pollutant loads.

☐ The Required Water Quality Volume is reduced through use of the LID site Design Credits.

☒ Calculations documenting that the treatment train meets the 80% TSS removal requirement and, if applicable, the 44% TSS removal pretreatment requirement, are provided.

Checklist for Stormwater Report

Checklist (continued)

Standard 4: Water Quality (continued)

☒ The BMP is sized (and calculations provided) based on:

☒ The ½" or 1" Water Quality Volume or

☐ The equivalent flow rate associated with the Water Quality Volume and documentation is provided showing that the BMP treats the required water quality volume.

☐ The applicant proposes to use proprietary BMPs, and documentation supporting use of proprietary BMP and proposed TSS removal rate is provided. This documentation may be in the form of the propriety BMP checklist found in Volume 2, Chapter 4 of the Massachusetts Stormwater Handbook and submitting copies of the TARP Report, STEP Report, and/or other third party studies verifying performance of the proprietary BMPs.

☐ A TMDL exists that indicates a need to reduce pollutants other than TSS and documentation showing that the BMPs selected are consistent with the TMDL is provided.

Standard 5: Land Uses With Higher Potential Pollutant Loads (LUHPPLs)

☐ The NPDES Multi-Sector General Permit covers the land use and the Stormwater Pollution Prevention Plan (SWPPP) has been included with the Stormwater Report.

☐ The NPDES Multi-Sector General Permit covers the land use and the SWPPP will be submitted ***prior to*** the discharge of stormwater to the post-construction stormwater BMPs.

☐ The NPDES Multi-Sector General Permit does ***not*** cover the land use.

☐ LUHPPLs are located at the site and industry specific source control and pollution prevention measures have been proposed to reduce or eliminate the exposure of LUHPPLs to rain, snow, snow melt and runoff, and been included in the long term Pollution Prevention Plan.

☐ All exposure has been eliminated.

☐ All exposure has ***not*** been eliminated and all BMPs selected are on MassDEP LUHPPL list.

☐ The LUHPPL has the potential to generate runoff with moderate to higher concentrations of oil and grease (e.g. all parking lots with >1000 vehicle trips per day) and the treatment train includes an oil grit separator, a filtering bioretention area, a sand filter or equivalent.

Standard 6: Critical Areas

☐ The discharge is near or to a critical area and the treatment train includes only BMPs that MassDEP has approved for stormwater discharges to or near that particular class of critical area.

☐ Critical areas and BMPs are identified in the Stormwater Report.

Checklist for Stormwater Report

Checklist (continued)

Standard 7: Redevelopments and Other Projects Subject to the Standards only to the maximum extent practicable

☐ The project is subject to the Stormwater Management Standards only to the maximum Extent Practicable as a:

- ☐ Limited Project
- ☐ Small Residential Projects: 5-9 single family houses or 5-9 units in a multi-family development provided there is no discharge that may potentially affect a critical area.
- ☐ Small Residential Projects: 2-4 single family houses or 2-4 units in a multi-family development with a discharge to a critical area
- ☐ Marina and/or boatyard provided the hull painting, service and maintenance areas are protected from exposure to rain, snow, snow melt and runoff
- ☐ Bike Path and/or Foot Path
- ☐ Redevelopment Project
- ☐ Redevelopment portion of mix of new and redevelopment.

☐ Certain standards are not fully met (Standard No. 1, 8, 9, and 10 must always be fully met) and an explanation of why these standards are not met is contained in the Stormwater Report.

☐ The project involves redevelopment and a description of all measures that have been taken to improve existing conditions is provided in the Stormwater Report. The redevelopment checklist found in Volume 2 Chapter 3 of the Massachusetts Stormwater Handbook may be used to document that the proposed stormwater management system (a) complies with Standards 2, 3 and the pretreatment and structural BMP requirements of Standards 4-6 to the maximum extent practicable and (b) improves existing conditions.

Standard 8: Construction Period Pollution Prevention and Erosion and Sedimentation Control

A Construction Period Pollution Prevention and Erosion and Sedimentation Control Plan must include the following information:

- Narrative;
- Construction Period Operation and Maintenance Plan;
- Names of Persons or Entity Responsible for Plan Compliance;
- Construction Period Pollution Prevention Measures;
- Erosion and Sedimentation Control Plan Drawings;
- Detail drawings and specifications for erosion control BMPs, including sizing calculations;
- Vegetation Planning;
- Site Development Plan;
- Construction Sequencing Plan;
- Sequencing of Erosion and Sedimentation Controls;
- Operation and Maintenance of Erosion and Sedimentation Controls;
- Inspection Schedule;
- Maintenance Schedule;
- Inspection and Maintenance Log Form.

☒ A Construction Period Pollution Prevention and Erosion and Sedimentation Control Plan containing the information set forth above has been included in the Stormwater Report.

Checklist for Stormwater Report

Checklist (continued)

Standard 8: Construction Period Pollution Prevention and Erosion and Sedimentation Control (continued)

☐ The project is highly complex and information is included in the Stormwater Report that explains why it is not possible to submit the Construction Period Pollution Prevention and Erosion and Sedimentation Control Plan with the application. A Construction Period Pollution Prevention and Erosion and Sedimentation Control has ***not*** been included in the Stormwater Report but will be submitted ***before*** land disturbance begins.

☒ The project is ***not*** covered by a NPDES Construction General Permit.

☐ The project is covered by a NPDES Construction General Permit and a copy of the SWPPP is in the Stormwater Report.

☐ The project is covered by a NPDES Construction General Permit but no SWPPP been submitted. The SWPPP will be submitted BEFORE land disturbance begins.

Standard 9: Operation and Maintenance Plan

☒ The Post Construction Operation and Maintenance Plan is included in the Stormwater Report and includes the following information:

- ☒ Name of the stormwater management system owners;
- ☒ Party responsible for operation and maintenance;
- ☒ Schedule for implementation of routine and non-routine maintenance tasks;
- ☒ Plan showing the location of all stormwater BMPs maintenance access areas;
- ☒ Description and delineation of public safety features;
- ☒ Estimated operation and maintenance budget; and
- ☒ Operation and Maintenance Log Form.

☐ The responsible party is ***not*** the owner of the parcel where the BMP is located and the Stormwater Report includes the following submissions:

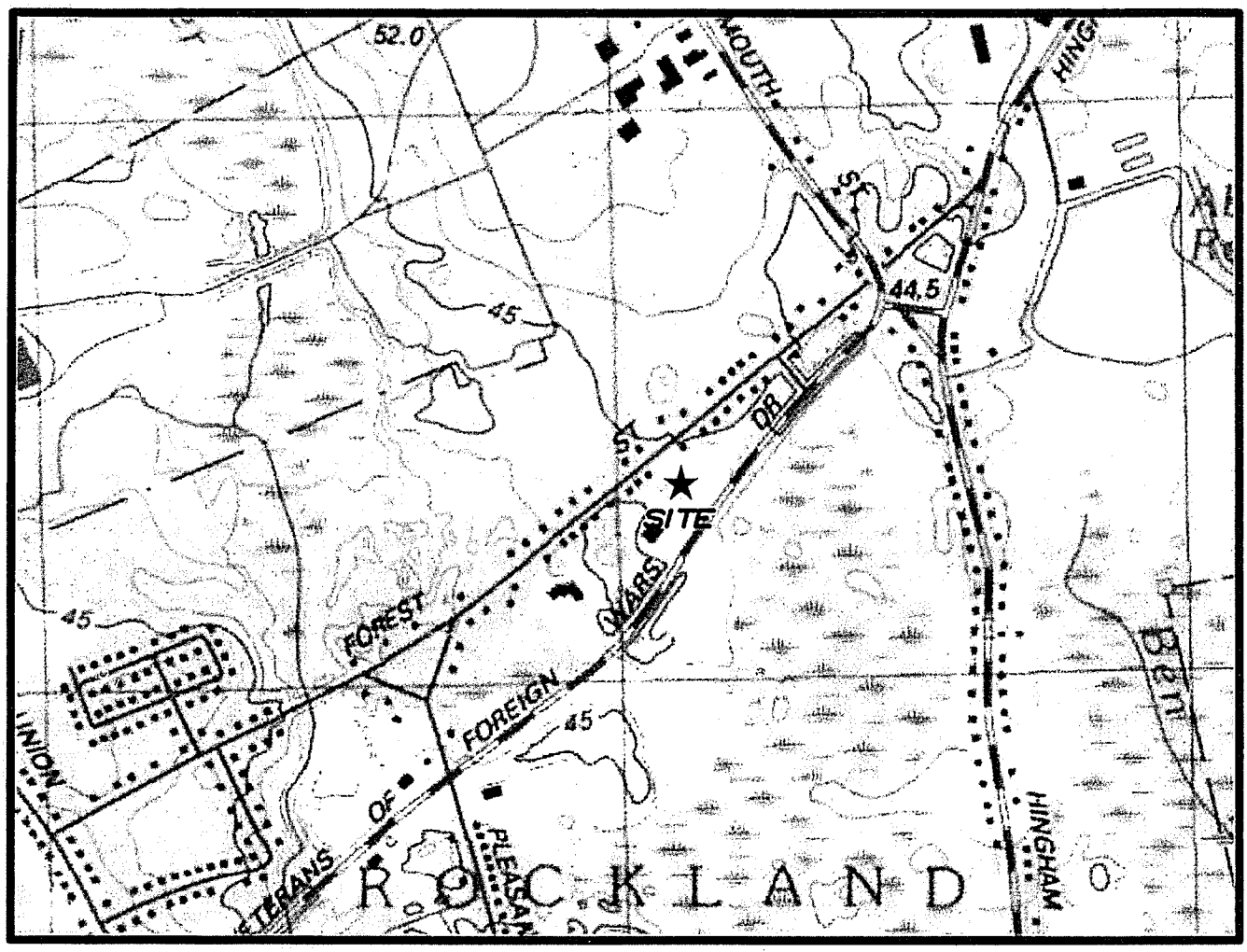
- ☐ A copy of the legal instrument (deed, homeowner's association, utility trust or other legal entity) that establishes the terms of and legal responsibility for the operation and maintenance of the project site stormwater BMPs;
- ☐ A plan and easement deed that allows site access for the legal entity to operate and maintain BMP functions.

Standard 10: Prohibition of Illicit Discharges

☒ The Long-Term Pollution Prevention Plan includes measures to prevent illicit discharges;

☒ An Illicit Discharge Compliance Statement is attached;

☐ NO Illicit Discharge Compliance Statement is attached but will be submitted ***prior to*** the discharge of any stormwater to post-construction BMPs.



SCALE: 1" = 1000'

U.S. GEOLOGICAL SURVEY
7.5 X 15 MINUTE SERIES

MORSE
ENGINEERING CO., INC.
42.12N
70.44W
10 NEW DRIFTWAY
P.O. BOX 92
SCITUATE, MA 02066
(781) 545-0895

FIGURE – 1

USGS LOCUS MAP
421 FOREST STREET
ROCKLAND, MASSACHUSETTS

0' 200' 400'

SCALE: 1" = 200'

MASS GIS

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ENGINEERING CO., INC.
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70.44W
10 NEW DRIFTWAY
P.O. BOX 92
SCITUATE, MA 02066
(781) 545-0895

FIGURE – 2

FEMA FLOOD MAP
421 FOREST STREET
ROCKLAND, MASSACHUSETTS

0' 100' 200'

SCALE: 1" = 100'

SCS SOILS MAP

MORSE
ENGINEERING CO., INC.
42.12N
70.44W
10 NEW DRIFTWAY
P.O. BOX 92
SCITUATE, MA 02066
(781) 545-0895

FIGURE – 3

SCS SOILS MAP
421 FOREST STREET
ROCKLAND, MASSACHUSETTS

Plymouth County, Massachusetts

453B—Gloucester - Canton complex, 3 to 8 percent slopes, extremely bouldery

Map Unit Setting

National map unit symbol: bd1b
Elevation: 0 to 400 feet
Mean annual precipitation: 41 to 54 inches
Mean annual air temperature: 43 to 54 degrees F
Frost-free period: 145 to 240 days
Farmland classification: Not prime farmland

Map Unit Composition

Gloucester, extremely bouldery, and similar soils: 50 percent
Canton, extremely bouldery, and similar soils: 45 percent
Minor components: 5 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Gloucester, Extremely Bouldery

Setting

Landform: Ground moraines, hills
Landform position (two-dimensional): Summit, shoulder
Landform position (three-dimensional): Interfluve
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Sandy and gravelly supraglacial meltout till

Typical profile

A - 0 to 3 inches: gravelly fine sandy loam
Bw1 - 3 to 11 inches: very gravelly fine sandy loam
Bw2 - 11 to 15 inches: very gravelly sandy loam
C1 - 15 to 24 inches: very gravelly loamy sand
C2 - 24 to 87 inches: very gravelly loamy sand

Properties and qualities

Slope: 3 to 8 percent
Surface area covered with cobbles, stones or boulders: 9.0 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Somewhat excessively drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): High to very high (5.95 to 19.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: Very low (about 2.3 inches)

Interpretive groups

Land capability classification (irrigated): None specified

Land capability classification (nonirrigated): 7s
Hydrologic Soil Group: A
Ecological site: F144AY032NH - Dry Till Uplands
Hydric soil rating: No

Description of Canton, Extremely Bouldery

Setting

Landform: Ridges, hills, till plains
Landform position (two-dimensional): Summit, shoulder
Landform position (three-dimensional): Interfluve
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Coarse-loamy eolian deposits over sandy and gravelly supraglacial meltout till

Typical profile

Oi - 0 to 1 inches: slightly decomposed plant material
Oe - 1 to 2 inches: moderately decomposed plant material
A - 2 to 3 inches: very fine sandy loam
E - 3 to 4 inches: very fine sandy loam
Bw1 - 4 to 5 inches: very fine sandy loam
Bw2 - 5 to 15 inches: very fine sandy loam
Bw3 - 15 to 24 inches: fine sandy loam
BC - 24 to 28 inches: gravelly loamy sand
2C1 - 28 to 49 inches: gravelly coarse sand
2C2 - 49 to 73 inches: gravelly loamy coarse sand

Properties and qualities

Slope: 8 to 15 percent
Surface area covered with cobbles, stones or boulders: 9.0 percent
Depth to restrictive feature: 20 to 36 inches to strongly contrasting textural stratification
Drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): High (1.98 to 5.95 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: Low (about 3.4 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7s
Hydrologic Soil Group: A
Ecological site: F144AY034CT - Well Drained Till Uplands
Hydric soil rating: No

Minor Components

Hinckley, bouldery

Percent of map unit: 3 percent
Landform: Outwash deltas, terraces, kames, eskers

Landform position (two-dimensional): Summit, shoulder
Landform position (three-dimensional): Tread
Down-slope shape: Convex
Across-slope shape: Convex
Hydric soil rating: No

Hollis

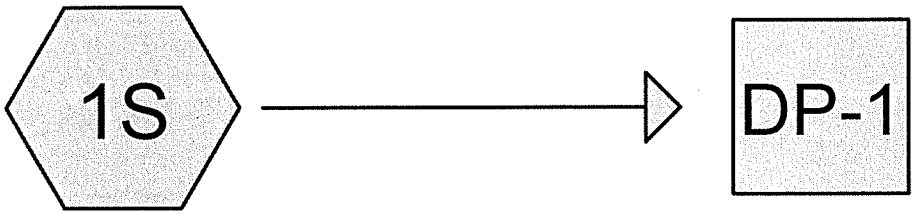
Percent of map unit: 2 percent
Landform: Ridges, hills
Landform position (two-dimensional): Summit, shoulder
Landform position (three-dimensional): Interfluve
Down-slope shape: Convex
Across-slope shape: Convex
Hydric soil rating: No

Data Source Information

Soil Survey Area: Plymouth County, Massachusetts
Survey Area Data: Version 16, Sep 10, 2023

APPENDIX A

- Existing Conditions HydroCAD Analysis



SUB-1

Subcat Reach Pond Link

Drainage Diagram for Existing Conditions
Prepared by {enter your company name here}, Printed 11/5/2024

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
0.027	30	Woods, Good, HSG A (1S)
0.237	49	Residential Lawn 50-75% Grass cover, Fair, HSG A (1S)
0.161	68	<50% Grass cover, Poor, HSG A (1S)
0.208	76	Gravel, HSG A (1S)
0.013	98	Residential Driveway and Walk (1S)
0.022	98	Residential Roof (1S)
0.669	64	**TOTAL AREA**

Soil Listing (all nodes)

Area (acres)	Soil Group	Subcatchment Numbers
0.633	HSG A	1S
0.000	HSG B	
0.000	HSG C	
0.000	HSG D	
0.035	Other	1S
0.669		**TOTAL AREA**

Time span=0.00-72.00 hrs, dt=0.02 hrs, 3601 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment 1S: SUB-1 Runoff Area=29,122 sf 5.25% Impervious Runoff Depth=0.67"
Tc=6.0 min CN=64 Runoff=0.42 cfs 0.037 af

Reach DP-1: Inflow=0.42 cfs 0.037 af
Outflow=0.42 cfs 0.037 af

Total Runoff Area = 0.669 ac Runoff Volume = 0.037 af Average Runoff Depth = 0.67"
94.75% Pervious = 0.633 ac 5.25% Impervious = 0.035 ac

Summary for Subcatchment 1S: SUB-1

Runoff = 0.42 cfs @ 12.11 hrs, Volume= 0.037 af, Depth= 0.67"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-72.00 hrs, dt= 0.02 hrs
Type III 24-hr 2 yr. storm Rainfall=3.43"

	Area (sf)	CN	Description
*	980	98	Residential Roof
*	550	98	Residential Driveway and Walk
*	10,320	49	Residential Lawn 50-75% Grass cover, Fair, HSG A
*	9,082	76	Gravel, HSG A
	1,180	30	Woods, Good, HSG A
	7,010	68	<50% Grass cover, Poor, HSG A
	29,122	64	Weighted Average
	27,592		94.75% Pervious Area
	1,530		5.25% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Summary for Reach DP-1:

Inflow Area = 0.669 ac, 5.25% Impervious, Inflow Depth = 0.67" for 2 yr. storm event
Inflow = 0.42 cfs @ 12.11 hrs, Volume= 0.037 af
Outflow = 0.42 cfs @ 12.11 hrs, Volume= 0.037 af, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.02 hrs

Time span=0.00-72.00 hrs, dt=0.02 hrs, 3601 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment 1S: SUB-1 Runoff Area=29,122 sf 5.25% Impervious Runoff Depth=1.62"
Tc=6.0 min CN=64 Runoff=1.20 cfs 0.090 af

Reach DP-1: Inflow=1.20 cfs 0.090 af
Outflow=1.20 cfs 0.090 af

Total Runoff Area = 0.669 ac Runoff Volume = 0.090 af Average Runoff Depth = 1.62"
94.75% Pervious = 0.633 ac 5.25% Impervious = 0.035 ac

Summary for Subcatchment 1S: SUB-1

Runoff = 1.20 cfs @ 12.10 hrs, Volume= 0.090 af, Depth= 1.62"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-72.00 hrs, dt= 0.02 hrs
Type III 24-hr 10 yr. storm Rainfall=5.06"

	Area (sf)	CN	Description
*	980	98	Residential Roof
*	550	98	Residential Driveway and Walk
*	10,320	49	Residential Lawn 50-75% Grass cover, Fair, HSG A
*	9,082	76	Gravel, HSG A
	1,180	30	Woods, Good, HSG A
	7,010	68	<50% Grass cover, Poor, HSG A
	29,122	64	Weighted Average
	27,592		94.75% Pervious Area
	1,530		5.25% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Summary for Reach DP-1:

Inflow Area = 0.669 ac, 5.25% Impervious, Inflow Depth = 1.62" for 10 yr. storm event
Inflow = 1.20 cfs @ 12.10 hrs, Volume= 0.090 af
Outflow = 1.20 cfs @ 12.10 hrs, Volume= 0.090 af, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.02 hrs

Time span=0.00-72.00 hrs, dt=0.02 hrs, 3601 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment 1S: SUB-1 Runoff Area=29,122 sf 5.25% Impervious Runoff Depth=2.32"
Tc=6.0 min CN=64 Runoff=1.77 cfs 0.129 af

Reach DP-1: Inflow=1.77 cfs 0.129 af
Outflow=1.77 cfs 0.129 af

Total Runoff Area = 0.669 ac Runoff Volume = 0.129 af Average Runoff Depth = 2.32"
94.75% Pervious = 0.633 ac 5.25% Impervious = 0.035 ac

Summary for Subcatchment 1S: SUB-1

Runoff = 1.77 cfs @ 12.09 hrs, Volume= 0.129 af, Depth= 2.32"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-72.00 hrs, dt= 0.02 hrs
Type III 24-hr 25 yr. storm Rainfall=6.08"

	Area (sf)	CN	Description
*	980	98	Residential Roof
*	550	98	Residential Driveway and Walk
*	10,320	49	Residential Lawn 50-75% Grass cover, Fair, HSG A
*	9,082	76	Gravel, HSG A
	1,180	30	Woods, Good, HSG A
	7,010	68	<50% Grass cover, Poor, HSG A
	29,122	64	Weighted Average
	27,592		94.75% Pervious Area
	1,530		5.25% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Summary for Reach DP-1:

Inflow Area = 0.669 ac, 5.25% Impervious, Inflow Depth = 2.32" for 25 yr. storm event
Inflow = 1.77 cfs @ 12.09 hrs, Volume= 0.129 af
Outflow = 1.77 cfs @ 12.09 hrs, Volume= 0.129 af, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.02 hrs

Time span=0.00-72.00 hrs, dt=0.02 hrs, 3601 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment 1S: SUB-1 Runoff Area=29,122 sf 5.25% Impervious Runoff Depth=3.50"
Tc=6.0 min CN=64 Runoff=2.72 cfs 0.195 af

Reach DP-1: Inflow=2.72 cfs 0.195 af
Outflow=2.72 cfs 0.195 af

Total Runoff Area = 0.669 ac Runoff Volume = 0.195 af Average Runoff Depth = 3.50"
94.75% Pervious = 0.633 ac 5.25% Impervious = 0.035 ac

Summary for Subcatchment 1S: SUB-1

Runoff = 2.72 cfs @ 12.09 hrs, Volume= 0.195 af, Depth= 3.50"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-72.00 hrs, dt= 0.02 hrs
Type III 24-hr 100 yr. storm Rainfall=7.65"

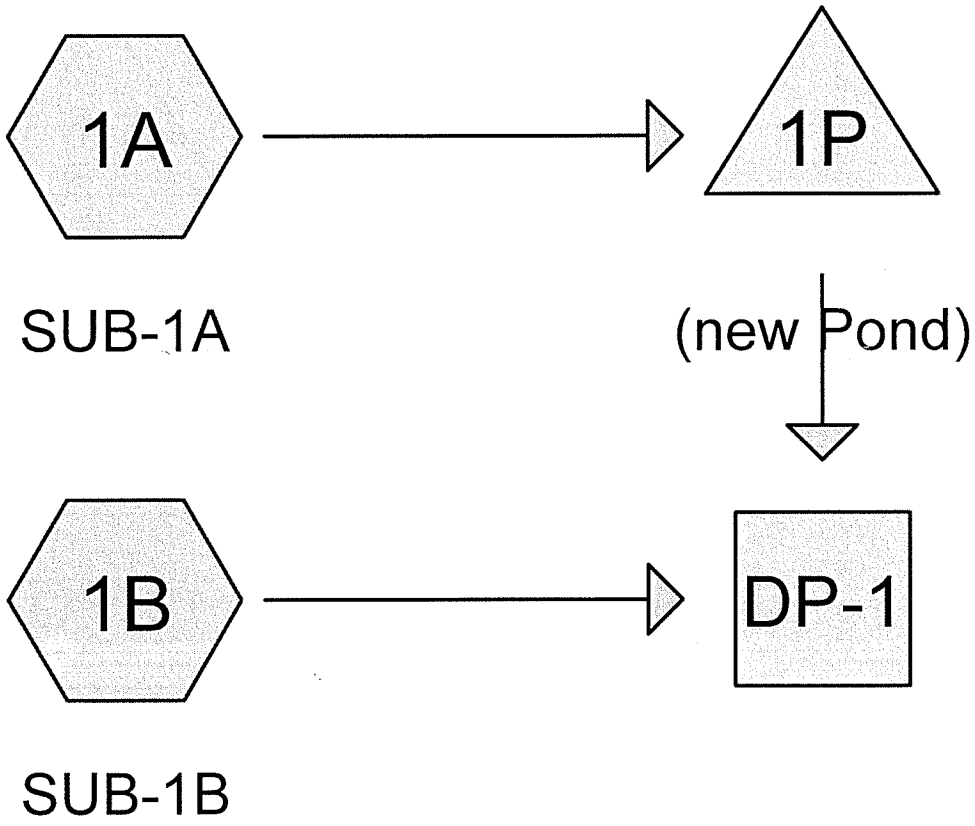
	Area (sf)	CN	Description
*	980	98	Residential Roof
*	550	98	Residential Driveway and Walk
*	10,320	49	Residential Lawn 50-75% Grass cover, Fair, HSG A
*	9,082	76	Gravel, HSG A
	1,180	30	Woods, Good, HSG A
	7,010	68	<50% Grass cover, Poor, HSG A
	29,122	64	Weighted Average
	27,592		94.75% Pervious Area
	1,530		5.25% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Summary for Reach DP-1:

Inflow Area = 0.669 ac, 5.25% Impervious, Inflow Depth = 3.50" for 100 yr. storm event
Inflow = 2.72 cfs @ 12.09 hrs, Volume= 0.195 af
Outflow = 2.72 cfs @ 12.09 hrs, Volume= 0.195 af, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.02 hrs



Subcat Reach Pond Link

Drainage Diagram for Proposed Conditions
Prepared by {enter your company name here}, Printed 11/5/2024

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
0.193	39	>75% Grass cover, Good, HSG A (1B)
0.237	49	Residential Lawn 50-75% Grass cover, Fair, HSG A (1B)
0.152	98	Paved (1A)
0.013	98	Residential Driveway and Walk (1B)
0.022	98	Residential Roof (1B)
0.052	98	Roof (1A)
0.669	64	**TOTAL AREA**

Soil Listing (all nodes)

Area (acres)	Soil Group	Subcatchment Numbers
0.429	HSG A	1B
0.000	HSG B	
0.000	HSG C	
0.000	HSG D	
0.239	Other	1A, 1B
0.669		**TOTAL AREA**

Pipe Listing (all nodes)

Line#	Node Number	In-Invert (feet)	Out-Invert (feet)	Length (feet)	Slope (ft/ft)	n	Diam/Width (inches)	Height (inches)	Fill (inches)
1	1P	136.40	134.10	25.0	0.0920	0.013	8.0	0.0	0.0

Time span=0.00-72.00 hrs, dt=0.02 hrs, 3601 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment 1A: SUB-1A Runoff Area=8,886 sf 100.00% Impervious Runoff Depth=3.20"
Tc=6.0 min CN=98 Runoff=0.68 cfs 0.054 af

Subcatchment 1B: SUB-1B Runoff Area=20,236 sf 7.56% Impervious Runoff Depth=0.15"
Tc=6.0 min CN=49 Runoff=0.02 cfs 0.006 af

Reach DP-1: Inflow=0.42 cfs 0.021 af
Outflow=0.42 cfs 0.021 af

Pond 1P: (new Pond) Peak Elev=136.83' Storage=0.016 af Inflow=0.68 cfs 0.054 af
Discarded=0.02 cfs 0.039 af Primary=0.42 cfs 0.015 af Outflow=0.44 cfs 0.054 af

Total Runoff Area = 0.669 ac Runoff Volume = 0.060 af Average Runoff Depth = 1.08"
64.23% Pervious = 0.429 ac 35.77% Impervious = 0.239 ac

Summary for Subcatchment 1A: SUB-1A

Runoff = 0.68 cfs @ 12.08 hrs, Volume= 0.054 af, Depth= 3.20"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-72.00 hrs, dt= 0.02 hrs
Type III 24-hr 2 yr. storm Rainfall=3.43"

	Area (sf)	CN	Description
*	2,250	98	Roof
*	6,636	98	Paved
	8,886	98	Weighted Average
	8,886		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Summary for Subcatchment 1B: SUB-1B

Runoff = 0.02 cfs @ 12.45 hrs, Volume= 0.006 af, Depth= 0.15"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-72.00 hrs, dt= 0.02 hrs
Type III 24-hr 2 yr. storm Rainfall=3.43"

	Area (sf)	CN	Description
*	980	98	Residential Roof
*	550	98	Residential Driveway and Walk
*	10,320	49	Residential Lawn 50-75% Grass cover, Fair, HSG A
	8,386	39	>75% Grass cover, Good, HSG A
	20,236	49	Weighted Average
	18,706		92.44% Pervious Area
	1,530		7.56% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Summary for Reach DP-1:

Inflow Area = 0.669 ac, 35.77% Impervious, Inflow Depth = 0.39" for 2 yr. storm event
Inflow = 0.42 cfs @ 12.18 hrs, Volume= 0.021 af
Outflow = 0.42 cfs @ 12.18 hrs, Volume= 0.021 af, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.02 hrs

Summary for Pond 1P: (new Pond)

Inflow Area = 0.204 ac,100.00% Impervious, Inflow Depth = 3.20" for 2 yr. storm event
Inflow = 0.68 cfs @ 12.08 hrs, Volume= 0.054 af
Outflow = 0.44 cfs @ 12.18 hrs, Volume= 0.054 af, Atten= 35%, Lag= 5.6 min
Discarded = 0.02 cfs @ 9.80 hrs, Volume= 0.039 af
Primary = 0.42 cfs @ 12.18 hrs, Volume= 0.015 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.02 hrs
Peak Elev= 136.83' @ 12.18 hrs Surf.Area= 0.010 ac Storage= 0.016 af

Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 148.1 min (903.1 - 755.0)

Volume	Invert	Avail.Storage	Storage Description
#1A	134.20'	0.010 af	**12.00'W x 36.00'L x 4.00'H Field A** 0.040 af Overall - 0.016 af Embedded = 0.024 af x 40.0% Voids
#2A	134.70'	0.011 af	**Galley 4x4x3** x 16 Inside #1 Inside= 42.0"W x 30.0"H => 8.91 sf x 3.50'L = 31.2 cf Outside= 48.0"W x 36.0"H => 10.81 sf x 4.00'L = 43.2 cf
		0.021 af	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Discarded	134.20'	**2.410 in/hr Exfiltration over Surface area**
#2	Primary	136.40'	**8.0" Round Culvert** L= 25.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 136.40' / 134.10' S= 0.0920 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior

Discarded OutFlow Max=0.02 cfs @ 9.80 hrs HW=134.24' (Free Discharge)
↑—**1=Exfiltration** (Exfiltration Controls 0.02 cfs)

Primary OutFlow Max=0.41 cfs @ 12.18 hrs HW=136.83' TW=0.00' (Dynamic Tailwater)
↑—**2=Culvert** (Inlet Controls 0.41 cfs @ 1.76 fps)

Time span=0.00-72.00 hrs, dt=0.02 hrs, 3601 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment 1A: SUB-1A Runoff Area=8,886 sf 100.00% Impervious Runoff Depth=4.82"
Tc=6.0 min CN=98 Runoff=1.01 cfs 0.082 af

Subcatchment 1B: SUB-1B Runoff Area=20,236 sf 7.56% Impervious Runoff Depth=0.66"
Tc=6.0 min CN=49 Runoff=0.21 cfs 0.026 af

Reach DP-1: Inflow=1.06 cfs 0.062 af
Outflow=1.06 cfs 0.062 af

Pond 1P: (new Pond) Peak Elev=137.14' Storage=0.018 af Inflow=1.01 cfs 0.082 af
Discarded=0.02 cfs 0.045 af Primary=0.85 cfs 0.037 af Outflow=0.87 cfs 0.082 af

Total Runoff Area = 0.669 ac Runoff Volume = 0.108 af Average Runoff Depth = 1.93"
64.23% Pervious = 0.429 ac 35.77% Impervious = 0.239 ac

Summary for Subcatchment 1A: SUB-1A

Runoff = 1.01 cfs @ 12.08 hrs, Volume= 0.082 af, Depth= 4.82"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-72.00 hrs, dt= 0.02 hrs
Type III 24-hr 10 yr. storm Rainfall=5.06"

	Area (sf)	CN	Description
*	2,250	98	Roof
*	6,636	98	Paved
	8,886	98	Weighted Average
	8,886		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Summary for Subcatchment 1B: SUB-1B

Runoff = 0.21 cfs @ 12.13 hrs, Volume= 0.026 af, Depth= 0.66"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-72.00 hrs, dt= 0.02 hrs
Type III 24-hr 10 yr. storm Rainfall=5.06"

	Area (sf)	CN	Description
*	980	98	Residential Roof
*	550	98	Residential Driveway and Walk
*	10,320	49	Residential Lawn 50-75% Grass cover, Fair, HSG A
	8,386	39	>75% Grass cover, Good, HSG A
	20,236	49	Weighted Average
	18,706		92.44% Pervious Area
	1,530		7.56% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Summary for Reach DP-1:

Inflow Area = 0.669 ac, 35.77% Impervious, Inflow Depth = 1.12" for 10 yr. storm event
Inflow = 1.06 cfs @ 12.13 hrs, Volume= 0.062 af
Outflow = 1.06 cfs @ 12.13 hrs, Volume= 0.062 af, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.02 hrs

Summary for Pond 1P: (new Pond)

Inflow Area = 0.204 ac,100.00% Impervious, Inflow Depth = 4.82" for 10 yr. storm event
Inflow = 1.01 cfs @ 12.08 hrs, Volume= 0.082 af
Outflow = 0.87 cfs @ 12.13 hrs, Volume= 0.082 af, Atten= 13%, Lag= 2.8 min
Discarded = 0.02 cfs @ 8.58 hrs, Volume= 0.045 af
Primary = 0.85 cfs @ 12.13 hrs, Volume= 0.037 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.02 hrs
Peak Elev= 137.14' @ 12.13 hrs Surf.Area= 0.010 ac Storage= 0.018 af

Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 123.4 min (871.2 - 747.8)

Volume	Invert	Avail.Storage	Storage Description
#1A	134.20'	0.010 af	**12.00'W x 36.00'L x 4.00'H Field A** 0.040 af Overall - 0.016 af Embedded = 0.024 af x 40.0% Voids
#2A	134.70'	0.011 af	**Galley 4x4x3** x 16 Inside #1 Inside= 42.0"W x 30.0"H => 8.91 sf x 3.50'L = 31.2 cf Outside= 48.0"W x 36.0"H => 10.81 sf x 4.00'L = 43.2 cf
		0.021 af	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Discarded	134.20'	**2.410 in/hr Exfiltration over Surface area**
#2	Primary	136.40'	**8.0" Round Culvert** L= 25.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 136.40' / 134.10' S= 0.0920 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior

Discarded OutFlow Max=0.02 cfs @ 8.58 hrs HW=134.24' (Free Discharge)
↑—**1=Exfiltration** (Exfiltration Controls 0.02 cfs)

Primary OutFlow Max=0.85 cfs @ 12.13 hrs HW=137.14' TW=0.00' (Dynamic Tailwater)
↑—**2=Culvert** (Inlet Controls 0.85 cfs @ 2.42 fps)

Time span=0.00-72.00 hrs, dt=0.02 hrs, 3601 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment 1A: SUB-1A Runoff Area=8,886 sf 100.00% Impervious Runoff Depth=5.84"
Tc=6.0 min CN=98 Runoff=1.21 cfs 0.099 af

Subcatchment 1B: SUB-1B Runoff Area=20,236 sf 7.56% Impervious Runoff Depth=1.11"
Tc=6.0 min CN=49 Runoff=0.46 cfs 0.043 af

Reach DP-1: Inflow=1.55 cfs 0.094 af
Outflow=1.55 cfs 0.094 af

Pond 1P: (new Pond) Peak Elev=137.41' Storage=0.018 af Inflow=1.21 cfs 0.099 af
Discarded=0.02 cfs 0.048 af Primary=1.09 cfs 0.051 af Outflow=1.11 cfs 0.099 af

Total Runoff Area = 0.669 ac Runoff Volume = 0.142 af Average Runoff Depth = 2.55"
64.23% Pervious = 0.429 ac 35.77% Impervious = 0.239 ac

Summary for Subcatchment 1A: SUB-1A

Runoff = 1.21 cfs @ 12.08 hrs, Volume= 0.099 af, Depth= 5.84"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-72.00 hrs, dt= 0.02 hrs
Type III 24-hr 25 yr. storm Rainfall=6.08"

	Area (sf)	CN	Description
*	2,250	98	Roof
*	6,636	98	Paved
	8,886	98	Weighted Average
	8,886		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Summary for Subcatchment 1B: SUB-1B

Runoff = 0.46 cfs @ 12.11 hrs, Volume= 0.043 af, Depth= 1.11"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-72.00 hrs, dt= 0.02 hrs
Type III 24-hr 25 yr. storm Rainfall=6.08"

	Area (sf)	CN	Description
*	980	98	Residential Roof
*	550	98	Residential Driveway and Walk
*	10,320	49	Residential Lawn 50-75% Grass cover, Fair, HSG A
	8,386	39	>75% Grass cover, Good, HSG A
	20,236	49	Weighted Average
	18,706		92.44% Pervious Area
	1,530		7.56% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Summary for Reach DP-1:

Inflow Area = 0.669 ac, 35.77% Impervious, Inflow Depth = 1.68" for 25 yr. storm event
Inflow = 1.55 cfs @ 12.12 hrs, Volume= 0.094 af
Outflow = 1.55 cfs @ 12.12 hrs, Volume= 0.094 af, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.02 hrs

Summary for Pond 1P: (new Pond)

Inflow Area = 0.204 ac,100.00% Impervious, Inflow Depth = 5.84" for 25 yr. storm event
Inflow = 1.21 cfs @ 12.08 hrs, Volume= 0.099 af
Outflow = 1.11 cfs @ 12.12 hrs, Volume= 0.099 af, Atten= 8%, Lag= 2.2 min
Discarded = 0.02 cfs @ 7.86 hrs, Volume= 0.048 af
Primary = 1.09 cfs @ 12.12 hrs, Volume= 0.051 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.02 hrs
Peak Elev= 137.41' @ 12.12 hrs Surf.Area= 0.010 ac Storage= 0.018 af

Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 113.8 min (858.7 - 744.9)

Volume	Invert	Avail.Storage	Storage Description
#1A	134.20'	0.010 af	**12.00'W x 36.00'L x 4.00'H Field A** 0.040 af Overall - 0.016 af Embedded = 0.024 af x 40.0% Voids
#2A	134.70'	0.011 af	**Galley 4x4x3** x 16 Inside #1 Inside= 42.0"W x 30.0"H => 8.91 sf x 3.50'L = 31.2 cf Outside= 48.0"W x 36.0"H => 10.81 sf x 4.00'L = 43.2 cf
		0.021 af	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Discarded	134.20'	**2.410 in/hr Exfiltration over Surface area**
#2	Primary	136.40'	**8.0" Round Culvert** L= 25.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 136.40' / 134.10' S= 0.0920 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior

Discarded OutFlow Max=0.02 cfs @ 7.86 hrs HW=134.24' (Free Discharge)
↑—**1=Exfiltration** (Exfiltration Controls 0.02 cfs)

Primary OutFlow Max=1.09 cfs @ 12.12 hrs HW=137.41' TW=0.00' (Dynamic Tailwater)
↑—**2=Culvert** (Inlet Controls 1.09 cfs @ 3.12 fps)

Time span=0.00-72.00 hrs, dt=0.02 hrs, 3601 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment 1A: SUB-1A Runoff Area=8,886 sf 100.00% Impervious Runoff Depth=7.41"
Tc=6.0 min CN=98 Runoff=1.53 cfs 0.126 af

Subcatchment 1B: SUB-1B Runoff Area=20,236 sf 7.56% Impervious Runoff Depth=1.94"
Tc=6.0 min CN=49 Runoff=0.94 cfs 0.075 af

Reach DP-1: Inflow=2.29 cfs 0.149 af
Outflow=2.29 cfs 0.149 af

Pond 1P: (new Pond) Peak Elev=137.79' Storage=0.019 af Inflow=1.53 cfs 0.126 af
Discarded=0.02 cfs 0.052 af Primary=1.36 cfs 0.074 af Outflow=1.39 cfs 0.126 af

Total Runoff Area = 0.669 ac Runoff Volume = 0.201 af Average Runoff Depth = 3.61"
64.23% Pervious = 0.429 ac 35.77% Impervious = 0.239 ac

Summary for Subcatchment 1A: SUB-1A

Runoff = 1.53 cfs @ 12.08 hrs, Volume= 0.126 af, Depth= 7.41"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-72.00 hrs, dt= 0.02 hrs
Type III 24-hr 100 yr. storm Rainfall=7.65"

	Area (sf)	CN	Description
*	2,250	98	Roof
*	6,636	98	Paved
	8,886	98	Weighted Average
	8,886		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Summary for Subcatchment 1B: SUB-1B

Runoff = 0.94 cfs @ 12.10 hrs, Volume= 0.075 af, Depth= 1.94"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-72.00 hrs, dt= 0.02 hrs
Type III 24-hr 100 yr. storm Rainfall=7.65"

	Area (sf)	CN	Description
*	980	98	Residential Roof
*	550	98	Residential Driveway and Walk
*	10,320	49	Residential Lawn 50-75% Grass cover, Fair, HSG A
	8,386	39	>75% Grass cover, Good, HSG A
	20,236	49	Weighted Average
	18,706		92.44% Pervious Area
	1,530		7.56% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Summary for Reach DP-1:

Inflow Area = 0.669 ac, 35.77% Impervious, Inflow Depth = 2.67" for 100 yr. storm event
Inflow = 2.29 cfs @ 12.11 hrs, Volume= 0.149 af
Outflow = 2.29 cfs @ 12.11 hrs, Volume= 0.149 af, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.02 hrs

Summary for Pond 1P: (new Pond)

Inflow Area = 0.204 ac,100.00% Impervious, Inflow Depth = 7.41" for 100 yr. storm event
Inflow = 1.53 cfs @ 12.08 hrs, Volume= 0.126 af
Outflow = 1.39 cfs @ 12.12 hrs, Volume= 0.126 af, Atten= 9%, Lag= 2.2 min
Discarded = 0.02 cfs @ 6.92 hrs, Volume= 0.052 af
Primary = 1.36 cfs @ 12.12 hrs, Volume= 0.074 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.02 hrs
Peak Elev= 137.79' @ 12.12 hrs Surf.Area= 0.010 ac Storage= 0.019 af

Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 103.0 min (844.8 - 741.8)

Volume	Invert	Avail.Storage	Storage Description
#1A	134.20'	0.010 af	**12.00'W x 36.00'L x 4.00'H Field A** 0.040 af Overall - 0.016 af Embedded = 0.024 af x 40.0% Voids
#2A	134.70'	0.011 af	**Galley 4x4x3** x 16 Inside #1 Inside= 42.0"W x 30.0"H => 8.91 sf x 3.50'L = 31.2 cf Outside= 48.0"W x 36.0"H => 10.81 sf x 4.00'L = 43.2 cf
		0.021 af	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Discarded	134.20'	**2.410 in/hr Exfiltration over Surface area**
#2	Primary	136.40'	**8.0" Round Culvert** L= 25.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 136.40' / 134.10' S= 0.0920 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior

Discarded OutFlow Max=0.02 cfs @ 6.92 hrs HW=134.24' (Free Discharge)
↑—**1=Exfiltration** (Exfiltration Controls 0.02 cfs)

Primary OutFlow Max=1.36 cfs @ 12.12 hrs HW=137.79' TW=0.00' (Dynamic Tailwater)
↑—**2=Culvert** (Inlet Controls 1.36 cfs @ 3.91 fps)

APPENDIX C

- Summary of Stormwater Standards Compliance
- TSS Removal Worksheet
- Illicit Discharge Compliance Statement

SUMMARY OF STORMWATER STANDARDS 1 – 10
421 Forest Street, Rockland, MA

Standard #1: ***No new stormwater conveyances (i.e. outfalls)...***

The project complies as it does not propose any new untreated stormwater outfalls. Runoff from the roof and parking/access areas will be captured and directed to deep sumped hooded catch basins and a subsurface infiltration system. It is the intent of the proposed design to follow the natural/existing conditions stormwater flow paths to the extent practicable.

Standard #2: ***Post-Development peak discharge rates do not exceed pre-development rates...***

The project complies as peak discharge rates and volumes of runoff for the 2, 10, 25 and 100-yr. storm events are lower in the post-development model than the pre-development model. See below for calculations of the:

Peak Discharge Rates (cfs):

Design Point #1:

	2-Yr.	10-Yr.	25-Yr	100-Yr.
Pre-Development	0.42	1.20	1.77	2.72
Post-Development	0.42	1.06	1.55	2.29

Volume of Runoff (ac-ft.):

Design Point #1:

	2-Yr.	10-Yr.	25-Yr	100-Yr.
Pre-Development	0.037	0.090	0.129	0.195
Post-Development	0.021	0.062	0.094	0.149

Standard #3: ***Loss of annual recharge to groundwater shall be eliminated...***

Recharge Volume = 0.60 inches of runoff X Total Impervious Area*

Therefore: Minimum Recharge Volume = 0.60 in. X 8,886 s.f. X (1 ft./12 in.) = 444 c.f. (min.)

PROVIDED RECHARGE = 828 c.f. (provided within subsurface recharge system)

Standard #4: ***Stormwater management systems...shall remove 80% of the average... TSS....***

The project proposes deep sump hooded catch basins and a subsurface recharge system to achieve the required TSS removal efficiencies.

Standard #5: Stormwater discharges from Land Uses with Higher Potential Pollutant Loads

Not applicable. The proposed land use is not considered a land use with higher potential pollutant loads.

Standard #6: Stormwater discharges to critical areas...

Not applicable. The site does not discharge to a critical area.

Standard #7: A redevelopment project is required to meet standards....only to the extent practicable

This project is considered a partial redevelopment. The project has been designed to comply with all standards.

Standard #8: Erosion &Sedimental Control Plan

A Construction Phase Erosion Control Maintenance Schedule &Checklist is submitted in Appendix A of this report.

Standard #9: A Long Term Operation & Maintenance Plan shall be developed...

A Post-Construction Phase – Best Management Practices – Inspection Schedule & Evaluation Checklist is submitted in Appendix A of this report.

Standard #10: All illicit discharges to the stormwater management system are prohibited.

An illicit discharge compliance statement is submitted in Appendix A of this report.

INSTRUCTIONS:

Version 1, Automated: Mar. 4, 2008

1. In BMP Column, click on Blue Cell to Activate Drop Down Menu
2. Select BMP from Drop Down Menu
3. After BMP is selected, TSS Removal and other Columns are automatically completed.

Location: 421 Forest Street, Rockland

TSS Removal Calculation Worksheet

B BMP[1]	C TSS Removal Rate[1]	D Starting TSS Load*	E Amount Removed (C*D)	F Remaining Load (D-E)
Deep Sump and Hooded Catch Basin	0.25	1.00	0.25	0.75
Subsurface Infiltration Structure	0.80	0.75	0.60	0.15
	0.00	0.15	0.00	0.15
	0.00	0.15	0.00	0.15
	0.00	0.15	0.00	0.15

Total TSS Removal = 85%

Separate Form Needs to be Completed for Each Outlet or BMP Train

Project: 24-201
Prepared By: JMH
Date: 8/27/2024

*Equals remaining load from previous BMP (E) which enters the BMP

Non-automated TSS Calculation Sheet must be used if Proprietary BMP Proposed

1. From MassDEP Stormwater Handbook Vol. 1

Illicit Discharge Compliance Statement

To: Town of Rockland

RE: 421 Forest Street

To Whom it May Concern:

This letter is a statement that to the best of my knowledge, no illicit discharges currently exist or are being proposed by me to the stormwater management system at 421 Forest Street.

Jeffrey M. Hassett, P.E.
Morse Engineering Company, Inc.

APPENDIX D

- Construction Phase Operation & Maintenance Plan
- Post Construction Operation & Maintenance Plan

Construction Phase
Operation & Maintenance Plan
Best Management Practices

MA DEP Stormwater Management Policy

Project

421 Forest Street
Rockland, MA 02370
Assessor's Map 14 Lot 79

Applicant

Melissa McInnis & Dennis Benoit
21 Accord Pond Drive
Hingham, MA 02043

Date: August 28, 2024

Prepared by:

MORSE
ENGINEERING CO., INC.
42.12N
70.44W

10 New Driftway, Suite 303
P.O. Box 92
Scituate, MA 02066
Tel. 781.545.0895
GMorse@Morsecoinc.com

Registered Professional Engineers,
Land Surveyors & Environmental Consultants

www.Morsecoinc.com

Construction Phase Operation & Maintenance Plan
Best Management Practices
421 Forest Street, Rockland, MA

Responsible Parties & Contact Information:

Applicant:

Melissa McInnis & Dennis Benoit
21 Accord Pond Drive
Hingham, MA 02043
melissa@benoitcorp.com, 781-718-2413

Contractor / Stormwater Manager:

Name:
Address:
Address:
Contact:

Inspection & Record Keeping:

The responsible party shall maintain an operation and maintenance log during construction to control construction-related impacts, including erosion, sedimentation and other pollutant sources and land disturbance activities.

The responsible party shall inspect the construction site at least once every 7 calendar days and within 24 hours of a storm event of ½ inch or greater. Inspections shall be performed until the site is fully stabilized and the temporary sedimentation controls have been removed. The inspector shall inspect each measure to determine if it was installed/performed correctly. The inspector shall also determine if the measures have been damaged and if so the corrective action.

The log shall be kept on-site at all times and shall be made available to MassDEP and Town officials upon request. Member and agents of MassDEP and the Town officials shall be allowed to enter and inspect the premises to evaluate and ensure that the responsible party complies with the Operation and Maintenance Plan requirements for each BMP.

Operation & Maintenance:

During land disturbance and construction activities, project proponents must implement controls that prevent erosion, control sediment movement, and stabilize exposed soils to prevent pollutants from moving offsite or entering wetlands or waters. Land disturbance activities include demolition, construction, clearing, excavation, grading, filling and reconstruction.

Construction activities increase the potential for erosion and sedimentation at a site which may adversely impact wetland resource areas. To prevent this impact, the following conditions shall be imposed to control erosion and sedimentation:

Stabilized Construction Entrance: A crushed stone construction entrance shall be installed at the proposed entrance to prevent the migration of mud and sediments off-site. The entrance shall be inspected weekly and maintained in good condition. Additional stone shall be applied as necessary. Mud and sediment tracked onto the roadway shall be removed immediately.

Stabilization Practices: Disturbed areas shall be stabilized and protected as soon as practicable. Disturbed areas shall be stabilized when construction activity in the area has ceased for more than 14 days unless not feasible due to snow cover or if construction activities will resume within 21 days after construction temporarily ceased. Stabilization measures include the following:

- Temporary seeding
- Geotextiles
- Mulching and Netting
- Permanent seeding

Air Quality/Dust: Dust can be generated by dumping, excavating and moving the raw materials and exposed soil storage during periods of mechanical disturbance, transfer operations or high winds. Measures to mitigate dust emissions shall be utilized to reduce emissions and to minimize related impacts. These measures include: watering areas of exposed soils on a regular basis, vegetative cover, calcium chloride, stone and the use of tarpaulin covered trucks when transporting material.

Storage and Disposal of Hazardous Materials: Hazardous materials shall be stored and disposed of in accordance with the U.S. Environmental Protection Agency hazardous waste regulations and all other applicable regulations to ensure they do not adversely impact the environment.

In the event of a spill, the supervisor is to first contact the Fire Department and then notify the Police Department, Department of Public Works, Board of Health, and Conservation Commission. The Fire Department will assess the spill and determine if additional notifications are necessary and the level of cleanup.

The following equipment and materials shall be stored on-site at all times; sorbent pads, sand bags, speedi-dri absorbent and square end shovels.

Stockpiling: Temporary construction phase soil storage piles shall be stabilized or protected with sediment trapping measures to keep soil in place and prevent sediment runoff. Temporary perimeter protection such as berms, dikes and silt fences shall be applied to all soil piles. If stockpile is to remain undisturbed for more than a 30 day period it shall be stabilized with vegetative cover.

Inlet protection (Silt Sacks) – Silt sacks shall be inspected on a weekly basis and after any major storm event. Accumulated sediment shall be removed at time of inspection and silt sacks shall be replaced as necessary.

Roadway Sweeping Maintenance Schedule – Roadway sweeping shall be performed along the roadway at the project entrance to remove excess sediments and reduce the amount of sediments that the drainage system shall have to remove from the runoff. The sweeping should be conducted on a daily basis.

Activation of Drainage System: As the drainage system is installed, precautions shall be taken to ensure that the drainage system remains free of silt and sediment. This may include the installation of haybales around drainage structures, along with silt pillows or silt sacks, or keeping the drainage components covered until such time as the drainage system is ready for activation. The drainage system shall be cleaned and flushed of all silt and sediment prior to activation and all silt and sediment vacuumed out of the system or flushed into a temporary silt sump in the drainage basin and then removed by hand and the area stabilized prior to activation.

Temporary Sediment Basin and Conveyance Swales: The stormwater basin shall be established with a stable growth of vegetation prior to any discharge to the basin. Prior to activation of the drainage system, stormwater runoff shall be conveyed via swales to a temporary sediment basin.

The temporary sediment basin and conveyance swales shall be inspected on a monthly basis and after all storm events. Trash, leaves, branches, etc. shall be removed from basin and channel areas. Silt, sand and sediment, if significant accumulation occurs, shall be removed by hand annually. Material shall be removed and disposed of in accordance with all applicable local, states and federal regulations. Care shall be taken to maintain vegetation growth within a basin. Grass shall be cut and weeds and brush removed or trimmed at regular intervals during the growing season. Reseeding and weed control may need to be performed periodically to maintain healthy, dense vegetation and maintain the pollutant removal efficiency of the basin. Any slope erosion within the basins shall be stabilized and repaired as soon as practical. Mowing shall be performed frequently enough to keep the vegetation in vigorous condition and to control encroachment of weeds and woody vegetation, however it should not be mowed too closely so as to reduce the filtering effect. Important items to check during inspection include: signs of differential settlement, cracking, erosion, leakage in the embankments, tree growth on the embankments, condition of riprap, sediment accumulation and the health of the turf.

Project Location: 421 Forest Street, Rockland, MA

Construction Phase: Erosion Control Maintenance Schedule & Checklist

Construction Practices

Best Management Practice	Inspection Frequency (1)	Date Inspected	Inspector	Minimum Maintenance and Key Items to Check (1)	Cleaning/Repair Needed: ☐yes ☐no (List Items)	Date of Cleaning/ Repair	Performed by
Construction Site Stabilization	Weekly			1. Construction Site Stabilization Inspection/ Maintenance, temporary seeding, mulching etc.			
Inlet Protection (Catchbasin grates within 100-ft of project boundary)	Weekly			1. Remove accumulated sediment from Silt Sacks. 2. Silt Sacks shall be replaced as necessary			
Staked Mulch Sock	Bi-Weekly			1 Remove accumulated silt. 2 Repair rips / bulges.			
Temporary Seeding	Monthly			Check for germination of seeds. Check for drainage/washouts.			
Mulching & Netting	Bi-Weekly			1. Mulch Maintenance			
Land Grading	Weekly			1. Check for washouts and/or gullies. 2. Check for accumulated silt.			
Permanent Seeding	Bi-Weekly			1. Permanent Seeding Inspection/ Maintenance			
Dust Control	Daily			Apply wetting agents Tarpaulin covered trucks Inspect landscaping			
Soil Stockpiling	Daily			1. Check haybales/silt fence around piles.			

Stormwater Control Manager _____

Post-Construction Phase
Operation & Maintenance Plan
Best Management Practices

MA DEP Stormwater Management Policy

Project

421 Forest Street
Rockland, MA 02370
Assessor's Map 14 Lot 79

Applicant

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Post Construction Phase Operation & Maintenance Plan
Best Management Practices
421 Forest Street, Rockland, MA

Responsible Parties & Contact Information:

Applicant:

Melissa McInnis & Dennis Benoit
21 Accord Pond Drive
Hingham, MA 02043
melissa@benoitcorp.com, 781-718-2413

Record Keeping:

The responsible party shall maintain an operation and maintenance log for a minimum of three years prior including inspections, repairs, replacement and disposal. The log shall be kept on-site at all times.

An annual inspection and maintenance report shall be performed by a Professional Engineer. The report shall be submitted to the Conservation Commission and Planning Board within thirty days after any maintenance has been performed.

The log shall be made available to MassDEP and the Town upon request. Members and agents of MassDEP and the Town shall be allowed to enter and inspect the premises to evaluate and ensure that the responsible party complies with the Operation and Maintenance Plan requirements for each BMP.

Operation & Maintenance:

In order to maintain the integrity of the stormwater management system, frequent inspections and maintenance shall be performed by the owner. The BMPs require continuous inspections and maintenance in order to function properly. The BMPs should be inspected and maintained as specified and after all major storm events.

Parking Lot and Driveway Sweeping Maintenance Schedule– Parking lot and driveway sweeping shall be performed to remove excess sediments and reduce the amount of sediments that the drainage system shall have to remove from the runoff. The sweeping should be conducted on a quarterly basis.

First Defense Particle Separator shall be inspected two time times per year and maintained in accordance with the attached manufacturer's recommendations. Disposal of accumulated sediment must be in accordance with applicable local, state and federal guidelines and regulations.

Subsurface Infiltration System shall be checked for infiltrative capacity on a quarterly basis and after any significant rainfall event. Additional inspections should be scheduled during the first few months to make sure that the system is exfiltrating within 72 hours of all storm events.

Illicit Discharges:

No illicit discharges shall be created. An illicit discharge is any discharge that is not composed entirely of stormwater.

Storage and Disposal of Hazardous Materials:

Hazardous materials shall be stored and disposed of in accordance with the U.S. Environmental Protection Agency hazardous waste regulations and all other applicable regulations to ensure they do not adversely impact the environment.

The exterior storage of hazardous materials shall be prohibited.

In the event of a spill, the supervisor is to first contact the Fire Department and then notify the Police Department, Highway Department, Board of Health, and Conservation Commission. The Fire Department will assess the spill and determine if additional notifications are necessary and the level of cleanup.

Pesticides, Herbicides and Fertilizers

Fertilizers shall be restricted to organic fertilizers only. Pesticides and herbicides shall be used sparingly and applied by a professional applicator licensed under the Massachusetts Department of Agriculture.

The exterior storage of fertilizers, herbicides and fertilizers shall be prohibited.

Costs and Funding

The funding for operation and maintenance of the roadway sweeping, particle separator and subsurface infiltration system is the responsibility of the property owner. The estimated annual cost for operation and maintenance of these items is $2,000.

Project Location: 421 Forest Street, Rockland, MA

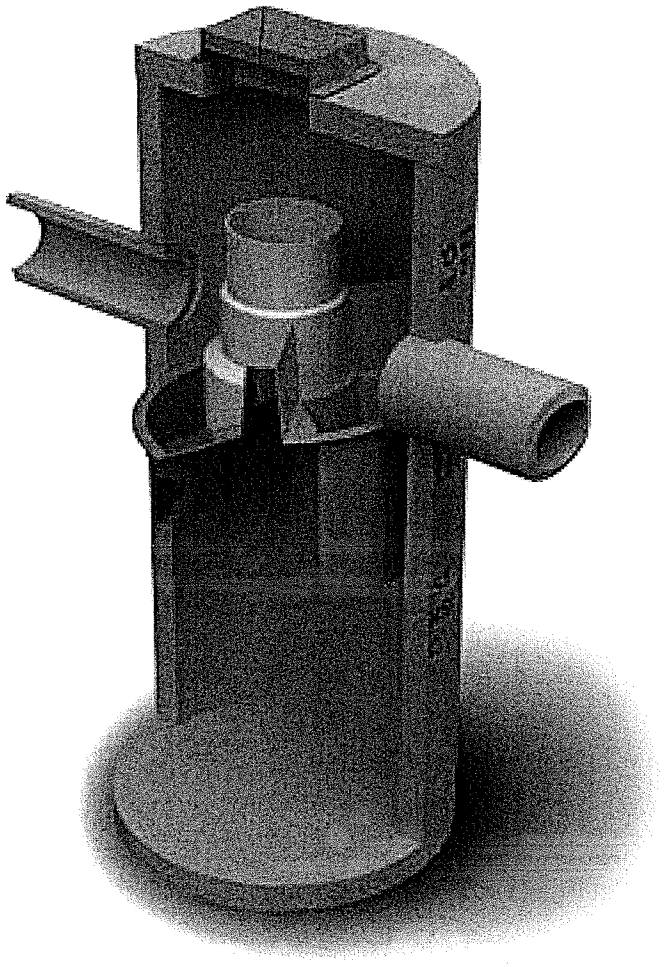
Stormwater Management – Post Construction Phase Long Term Operation & Maintenance Plan
Best Management Practices – Inspection Schedule and Evaluation Checklist

Long Term Practices

Best Management Practice	Inspection Frequency (1)	Date Inspected	Inspector	Minimum Maintenance and Key Items to Check (1)	Cleaning/Repair Needed: ☐yes ☐no (List Items)	Date of Cleaning/ Repair	Performed by
Driveway Sweeping	Quarterly (Primarily in spring and fall)			Sweep with regenerative air sweeper.			
First Defense Particle Separator	Twice per year			Refer to manufacturer's recommendations			
Subsurface Infiltration System	Quarterly			Check for infiltrative capacity			

Stormwater Control Manager _____

Hydro International®



Operation and Maintenance Manual

First Defense® and First Defense® High Capacity

Vortex Separator for Stormwater Treatment

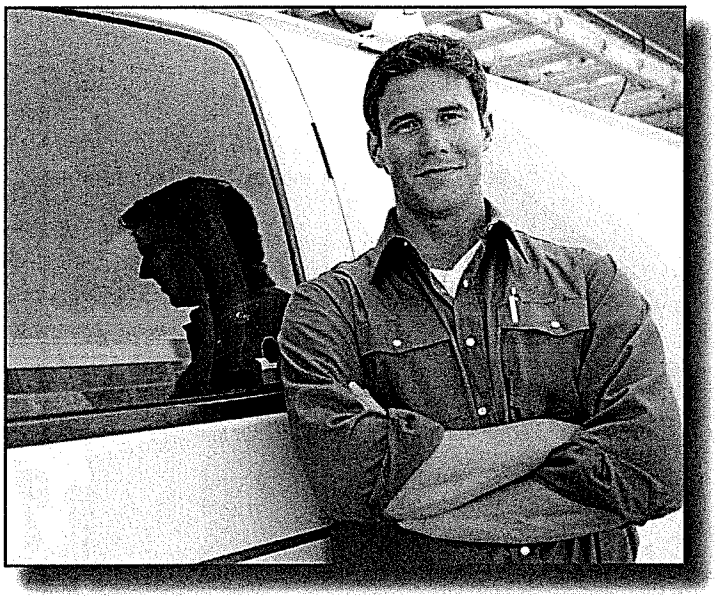
Table of Contents

Hydro International (Stormwater), 94 Hutchins Drive, Portland ME 04102
Tel: (207) 756-6200 Fax: (207) 756-6212 Web: www.hydro-int.com

Hydro Maintenance Services

Hydro International has been engineering stormwater treatment systems for over 30 years. We understand the mechanics of removing pollutants from stormwater and how to keep systems running at an optimal level.

Nobody Knows our Systems Better than we do



Avoid Service Negligence

Sanitation services providers not intimately familiar with stormwater treatment systems are at risk of the following:

- Inadvertently breaking parts or failing to clean/replace system components appropriately.
- Charging you for more frequent maintenance because they lacked the tools to service your system properly in the first place.
- Billing you for replacement parts that might have been covered under your Hydro warranty plan
- Charging for maintenance that may not yet have been required.

Leave the Dirty Work to us

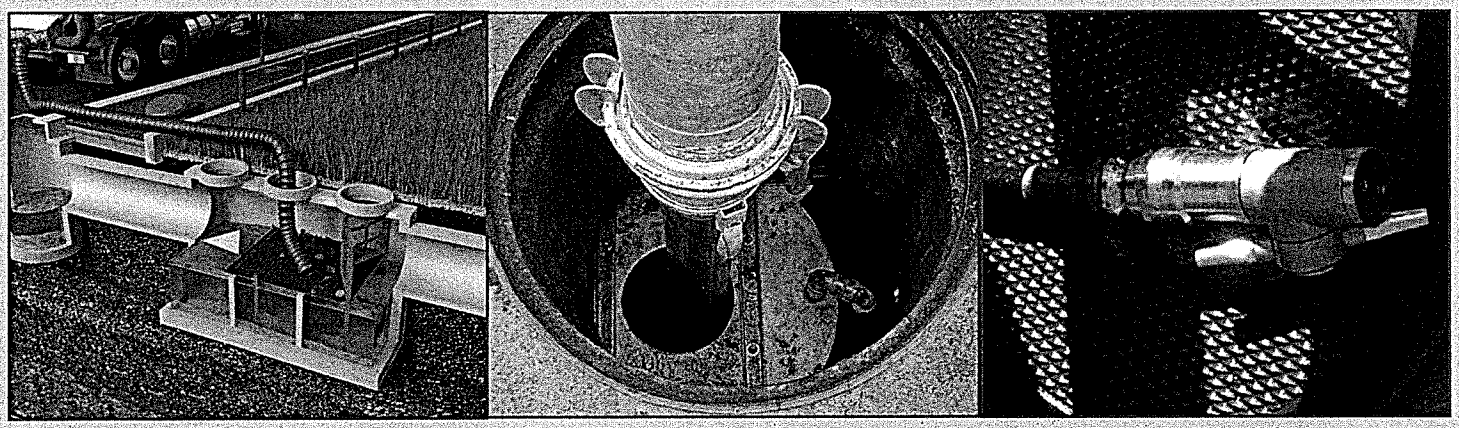
Trash, sediment and polluted water is stored inside treatment systems until they are removed by our team with a vactor truck. Sometimes teams must physically enter the system chambers in order to prepare the system for maintenance and install any replacement parts. Services include but are not limited to:

- Solids removal
- Removal of liquid pollutants
- Replacement media installation (when applicable)

Hydro International (Stormwater), 94 Hutchins Drive, Portland ME 04102
Tel: (207) 756-6200 Fax: (207) 756-6212 Web: www.hydro-int.com

Better Tools, Better Results

Not all vactor trucks are created equal. Appropriate tools and suction power are needed to service stormwater systems appropriately. Companies who don't specialize in stormwater treatment won't have the tools to properly clean systems or install new parts.

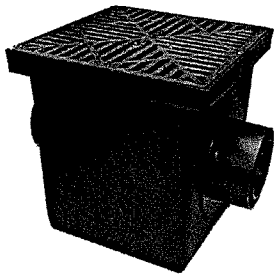


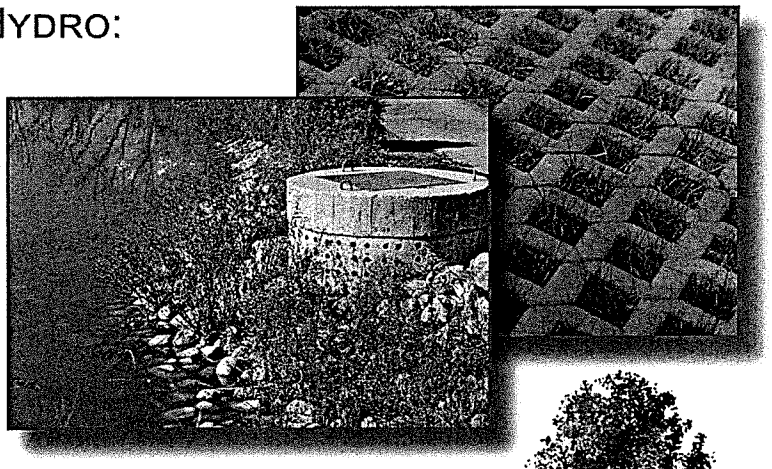
Service Warranty

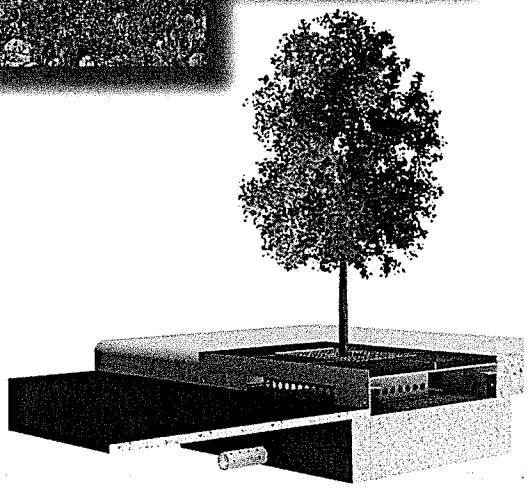
Make sure you're not paying for service that is covered under your warranty plan. Only Hydro International's service teams can identify tune-ups that should be on us, not you.

Treatment Systems Serviced by Hydro:

- Stormwwater filters
- Stormwater separators
- Baffle boxes
- Biofilters/biorention systems
- Storage structures
- Catch basins
- Stormwater ponds
- Permeable pavement







I. First Defense® by Hydro International

Introduction

The First Defense® is an enhanced vortex separator that combines an effective and economical stormwater treatment chamber with an integral peak flow bypass. It efficiently removes total suspended solids (TSS), trash and hydrocarbons from stormwater runoff without washing out previously captured pollutants. The First Defense® is available in several model configurations (refer to *Section II. Model Sizes & Configurations*, page 4) to accommodate a wide range of pipe sizes, peak flows and depth constraints.

Operation

The First Defense® operates on simple fluid hydraulics. It is self-activating, has no moving parts, no external power requirement and is fabricated with durable non-corrosive components. No manual procedures are required to operate the unit and maintenance is limited to monitoring accumulations of stored pollutants and periodic clean-outs. The First Defense® has been designed to allow for easy and safe access for inspection, monitoring and clean-out procedures. Neither entry into the unit nor removal of the internal components is necessary for maintenance, thus safety concerns related to confined-space-entry are avoided.

Pollutant Capture and Retention

The internal components of the First Defense® have been designed to optimize pollutant capture. Sediment is captured and retained in the base of the unit, while oil and floatables are stored on the water surface in the inner volume (Fig.1).

The pollutant storage volumes are isolated from the built-in bypass chamber to prevent washout during high-flow storm events. The sump of the First Defense® retains a standing water level between storm events. This ensures a quiescent flow regime at the onset of a storm, preventing resuspension and washout of pollutants captured during previous events.

Accessories such as oil absorbent pads are available for enhanced oil removal and storage. Due to the separation of the oil and floatable storage volume from the outlet, the potential for washout of stored pollutants between clean-outs is minimized.

Applications

- Stormwater treatment at the point of entry into the drainage line
- Sites constrained by space, topography or drainage profiles with limited slope and depth of cover
- Retrofit installations where stormwater treatment is placed on or tied into an existing storm drain line
- Pretreatment for filters, infiltration and storage

Advantages

- Inlet options include surface grate or multiple inlet pipes
- Integral high capacity bypass conveys large peak flows without the need for "offline" arrangements using separate junction manholes
- Proven to prevent pollutant washout at up to 500% of its treatment flow
- Long flow path through the device ensures a long residence time within the treatment chamber, enhancing pollutant settling
- Delivered to site pre-assembled and ready for installation

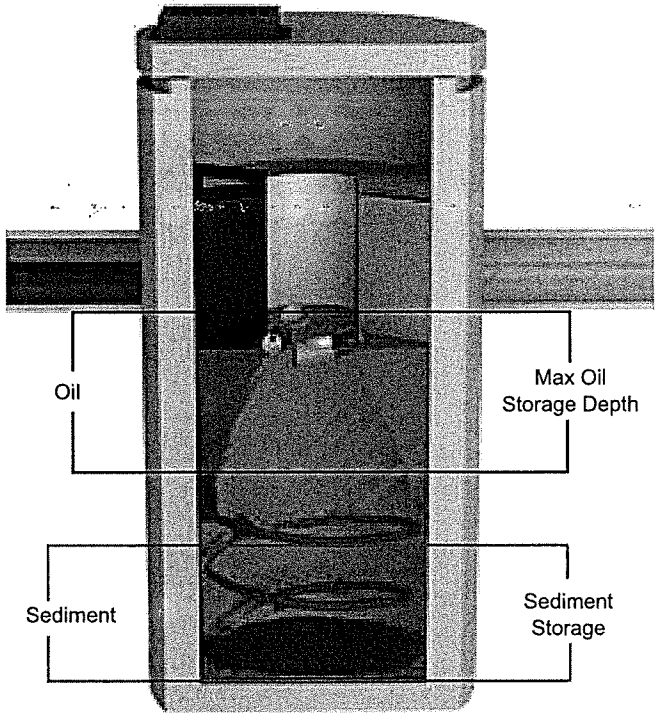


Fig.1 Pollutant storage volumes in the First Defense®.

II. Model Sizes & Configurations

The First Defense® inlet and internal bypass arrangements are available in several model sizes and configurations. The components of the First Defense®-4HC and First Defense®-6HC have modified geometries as to allow greater design flexibility needed to accommodate various site constraints.

All First Defense® models include the internal components that are designed to remove and retain total suspended solids (TSS), gross solids, floatable trash and hydrocarbons (Fig.2a - 2b). First Defense® model parameters and design criteria are shown in Table 1.

First Defense® Components

1. **Built-In Bypass**
2. **Inlet Pipe**
3. **Inlet Chute**
4. **Floatables Draw-off Port**
5. **Outlet Pipe**
6. **Floatables Storage**
7. **Sediment Storage**
8. **Inlet Grate or Cover**

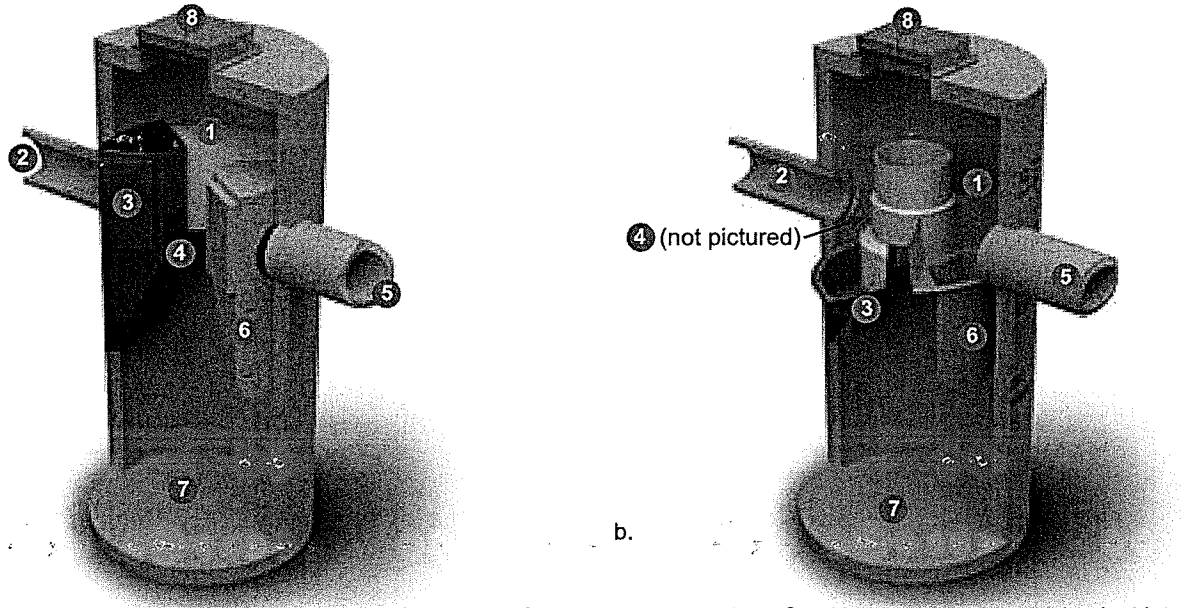


Fig.2a) First Defense®-4 and First Defense®-6; b) First Defense®-4HC and First Defense®-6HC, with higher capacity dual internal bypass and larger maximum pipe diameter.

First Defense® High Capacity Model Number	Diameter	Typical TSS Treatment Flow Rates		Peak Online Flow Rate	Maximum Pipe Diameter[1]	Oil Storage Capacity	Typical Sediment Storage Capacity[2]	Minimum Distance from Outlet Invert to Top of Rim[3]	Standard Distance from Outlet Invert to Sump Floor
		NJDEP Certified	106µm						
	(ft / m)	(cfs / L/s)	(cfs / L/s)	(cfs / L/s)	(in / mm)	(gal / L)	(yd^3 / m^3)	(ft / m)	(ft / m)
FD-3HC	3 / 0.9	0.84 / 23.7	1.60 / 45.3	15 / 424	18 / 457	125 / 473	0.4 / 0.3	2.0 - 3.5 / 0.6 - 1.0	3.71 / 1.13
FD-4HC	4 / 1.2	1.50 / 42.4	1.88 / 50.9	18 / 510	24 / 600	191 / 723	0.7 / 0.5	2.3 - 3.9 / 0.7 - 1.2	4.97 / 1.5
FD-5HC	5 / 1.5	2.34 / 66.2	2.94 / 82.1	20 / 566	24 / 609	300 / 1135	1.1 / .84	2.5 - 4.5 / 0.7 - 1.3	5.19 / 1.5
FD-6HC	6 / 1.8	3.38 / 95.7	4.73 / 133.9	32 / 906	30 / 750	496 / 1,878	1.6 / 1.2	3.0 - 5.1 / 0.9 - 1.6	5.97 / 1.8
FD-8HC	8 / 2.4	6.00 / 169.9	7.52 / 212.9	50 / 1,415	48 / 1219	1120 / 4239	2.8 / 2.1	3.0 - 6.0 / 0.9 -1.8	7.40 / 2.2

[1]Contact Hydro International when larger pipe sizes are required.
[2]Contact Hydro International when custom sediment storage capacity is required.
[3]Minimum distance for models depends on pipe diameter.

III. Maintenance

Overview

The First Defense® protects the environment by removing a wide range of pollutants from stormwater runoff. Periodic removal of these captured pollutants is essential to the continuous, long-term functioning of the First Defense®. The First Defense® will capture and retain sediment and oil until the sediment and oil storage volumes are full to capacity. When sediment and oil storage capacities are reached, the First Defense® will no longer be able to store removed sediment and oil. Maximum pollutant storage capacities are provided in Table 1.

The First Defense® allows for easy and safe inspection, monitoring and clean-out procedures. A commercially or municipally owned sump-vac is used to remove captured sediment and floatables. Access ports are located in the top of the manhole.

Maintenance events may include Inspection, Oil & Floatables Removal, and Sediment Removal. Maintenance events do not require entry into the First Defense®, nor do they require the internal components of the First Defense® to be removed. In the case of inspection and floatables removal, a vactor truck is not required. However, a vactor truck is required if the maintenance event is to include oil removal and/or sediment removal.

Maintenance Equipment Considerations

The internal components of the First Defense®-HC have a centrally located circular shaft through which the sediment storage sump can be accessed with a sump vac hose. The open diameter of this access shaft is 15 inches in diameter (Fig.3). Therefore, the nozzle fitting of any vactor hose used for maintenance should be less than 15 inches in diameter.

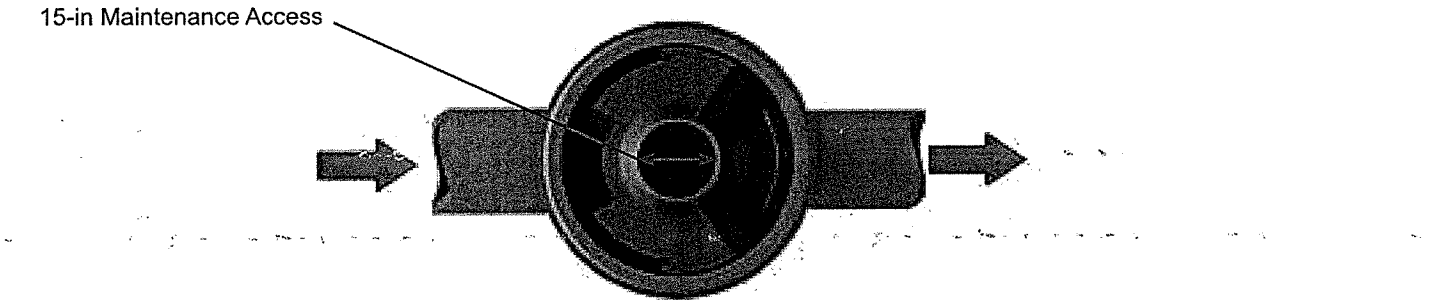


Fig.3 The central opening to the sump of the First Defense®-HC is 15 inches in diameter.

Determining Your Maintenance Schedule

The frequency of clean out is determined in the field after installation. During the first year of operation, the unit should be inspected every six months to determine the rate of sediment and floatables accumulation. A simple probe such as a Sludge-Judge® can be used to determine the level of accumulated solids stored in the sump. This information can be recorded in the maintenance log (see page 9) to establish a routine maintenance schedule.

The vactor procedure, including both sediment and oil / flotables removal, for a 6-ft First Defense® typically takes less than 30 minutes and removes a combined water/oil volume of about 765 gallons.

Inspection Procedures

1. Set up any necessary safety equipment around the access port or grate of the First Defense® as stipulated by local ordinances. Safety equipment should notify passing pedestrian and road traffic that work is being done.

2. Remove the grate or lid to the manhole.

3. Without entering the vessel, look down into the chamber to inspect the inside. Make note of any irregularities. Fig.4 shows the standing water level that should be observed.

4. Without entering the vessel, use the pole with the skimmer net to remove floatables and loose debris from the components and water surface.

5. Using a sediment probe such as a Sludge Judge®, measure the depth of sediment that has collected in the sump of the vessel.

6. On the Maintenance Log (see page 9), record the date, unit location, estimated volume of floatables and gross debris removed, and the depth of sediment measured. Also note any apparent irregularities such as damaged components or blockages.

7. Securely replace the grate or lid.

8. Take down safety equipment.

9. Notify Hydro International of any irregularities noted during inspection.

Floatables and Sediment Clean Out

Floatables clean out is typically done in conjunction with sediment removal. A commercially or municipally owned sump-vac is used to remove captured sediment and floatables (Fig.5).

Floatables and loose debris can also be netted with a skimmer and pole. The access port located at the top of the manhole provides unobstructed access for a vactor hose and skimmer pole to be lowered to the base of the sump.

Scheduling

- Floatables and sump clean out are typically conducted once a year during any season.

- Floatables and sump clean out should occur as soon as possible following a spill in the contributing drainage area.

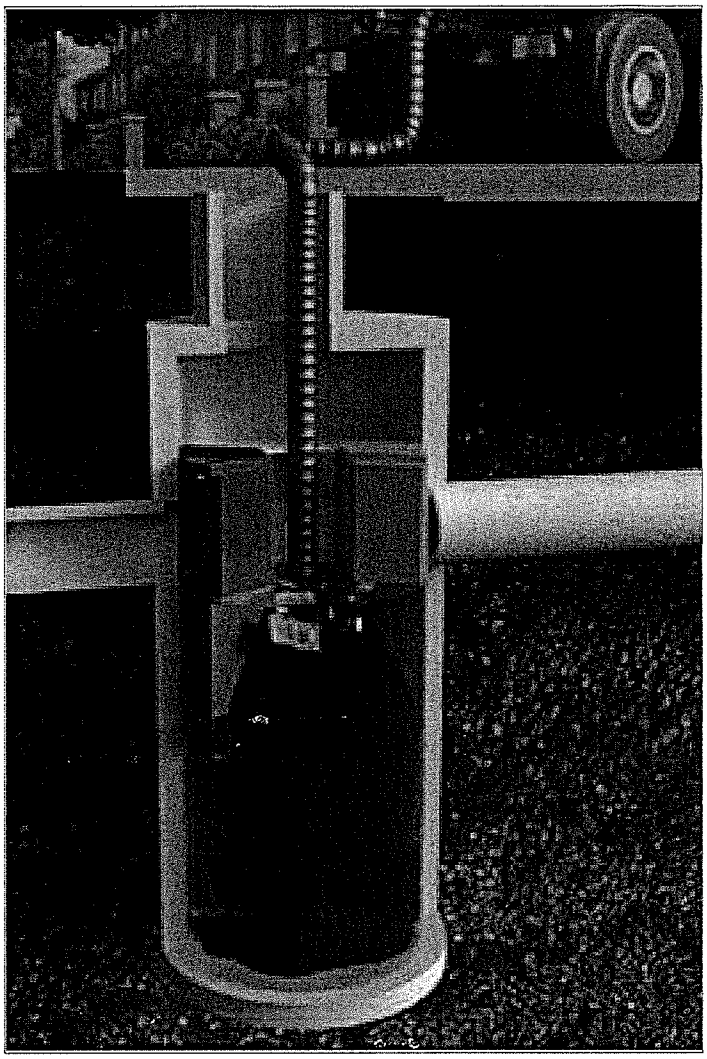


Fig.4 Floatables are removed with a vactor hose (First Defense model FD-4, shown).

Recommended Equipment

- Safety Equipment (traffic cones, etc)
- Crow bar or other tool to remove grate or lid
- Pole with skimmer or net (if only floatables are being removed)
- Sediment probe (such as a Sludge Judge®)
- Vactor truck (flexible hose recommended)
- First Defense® Maintenance Log

Floatables and sediment Clean Out Procedures

1. Set up any necessary safety equipment around the access port or grate of the First Defense® as stipulated by local ordinances. Safety equipment should notify passing pedestrian and road traffic that work is being done.

2. Remove the grate or lid to the manhole.

3. Without entering the vessel, look down into the chamber to inspect the inside. Make note of any irregularities.

4. Remove oil and floatables stored on the surface of the water with the vactor hose (Fig.5) or with the skimmer or net (not pictured).

5. Using a sediment probe such as a Sludge Judge®, measure the depth of sediment that has collected in the sump of the vessel and record it in the Maintenance Log (page 9).

6. Once all floatables have been removed, drop the vactor hose to the base of the sump. Vactor out the sediment and gross debris off the sump floor (Fig.5).

7. Retract the vactor hose from the vessel.

8. On the Maintenance Log provided by Hydro International, record the date, unit location, estimated volume of floatables and gross debris removed, and the depth of sediment measured. Also note any apparent irregularities such as damaged components, blockages, or irregularly high or low water levels.

9. Securely replace the grate or lid.

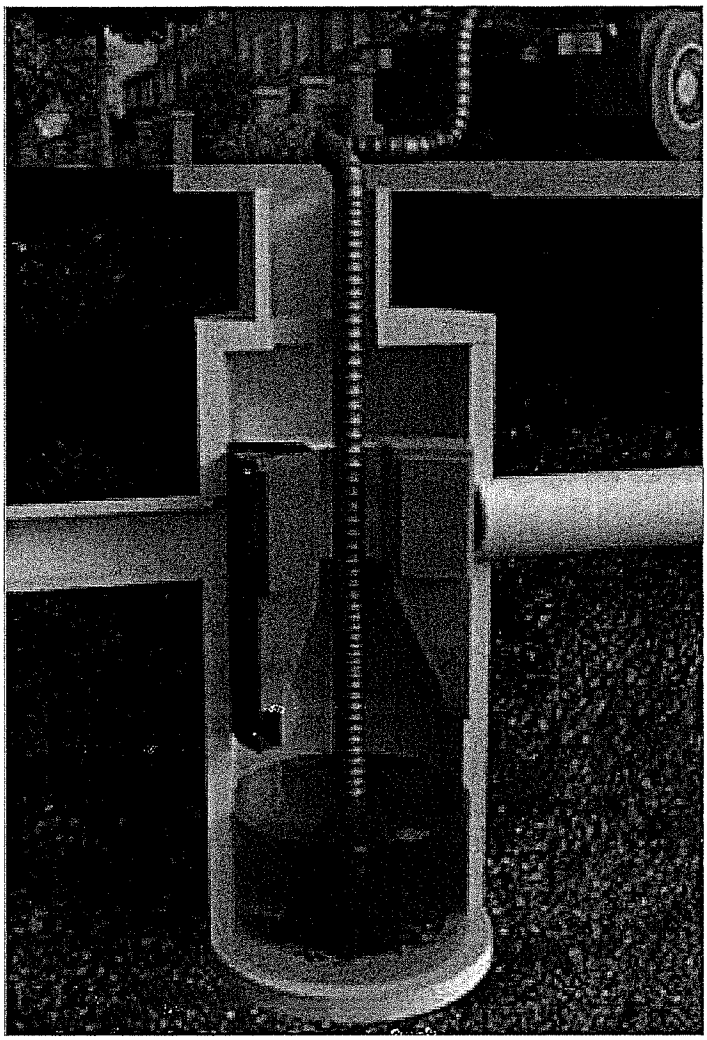


Fig.5 Sediment is removed with a vactor hose (First Defense model FD-4, shown).

Maintenance at a Glance

Inspection	- Regularly during first year of installation - Every 6 months after the first year of installation
Oil and Floatables Removal	- Once per year, with sediment removal - Following a spill in the drainage area
Sediment Removal	- Once per year or as needed - Following a spill in the drainage area
NOTE: For most clean outs the entire volume of liquid does not need to be removed from the manhole. Only remove the first few inches of oils and floatables from the water surface to reduce the total volume of liquid removed during a clean out.	

Hydro International®

First Defense® Installation Log

HYDRO INTERNATIONAL REFERENCE NUMBER:	
SITE NAME:	
SITE LOCATION:	
OWNER:	CONTRACTOR:
CONTACT NAME:	CONTACT NAME:
COMPANY NAME:	COMPANY NAME:
ADDRESS:	ADDRESS:
TELEPHONE:	TELEPHONE:
FAX:	FAX:

INSTALLATION DATE: / /

MODEL SIZE (CIRCLE ONE): **FD-4** **FD-4HC** **FD-6** **FD-6HC**

INLET (CIRCLE ALL THAT APPLY): **GRATED INLET (CATCH BASIN)** **INLET PIPE (FLOW THROUGH)**

Hydro International (Stormwater), 94 Hutchins Drive, Portland ME 04102
Tel: (207) 756-6200 Fax: (207) 756-6212 Web: www.hydro-int.com

Hydro International®

First Defense® Inspection and Maintenance Log

Date	Initials	Depth of Floatables and Oils	Sediment Depth Measured	Volume of Sediment Removed	Site Activity and Comments

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Hydro International®

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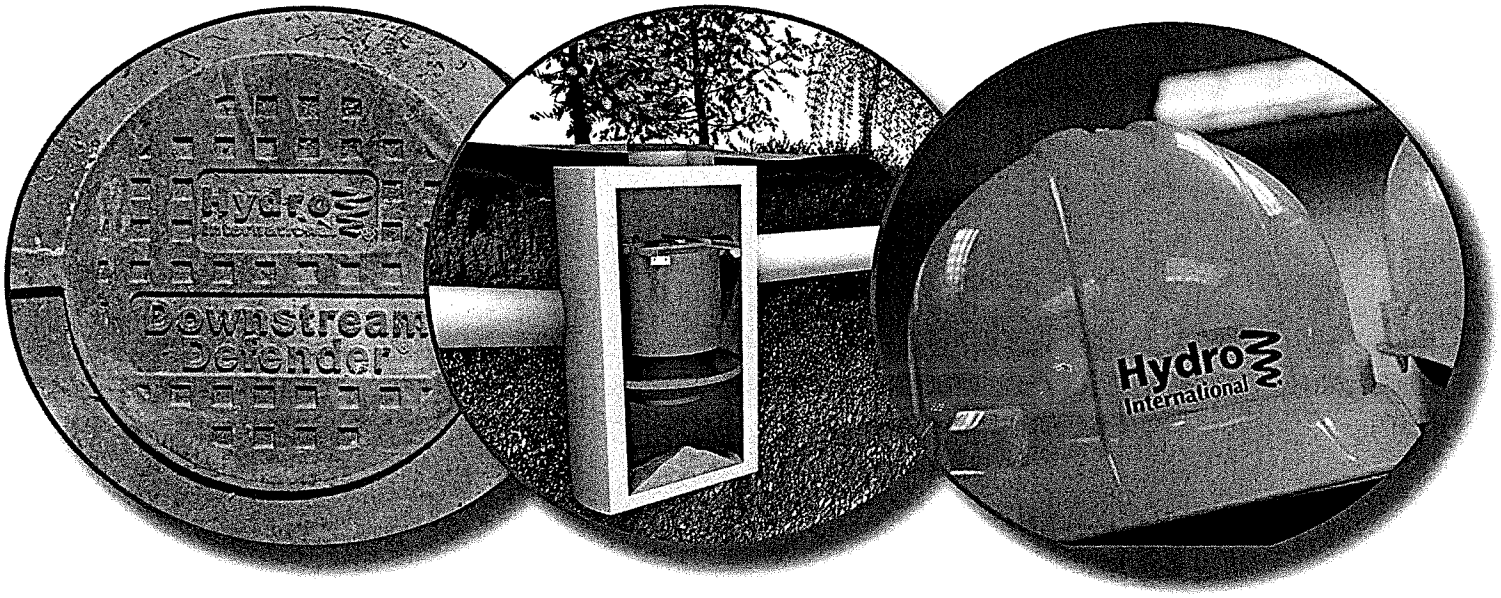

CALL **1 (888) 382-7808** TO SCHEDULE AN INSPECTION

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